POWER

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Announcing the Winners in the Power Prize Contest

For articles showing the most commendable improvement in the results obtained from the modernization, reorganization or improved operation of a power plant.

First Prize of $500
is awarded to
LYBRAND SMITH
Lieut. Commander U. S. Navy
for his contribution on
"Horsepower of the Mind"

Second Prize of $250
is awarded to
ROBERT S. BAYNTUM
for his paper on
"Power Cost per Ton of Product Cut One-Third"

Third Prize of $100
is awarded to
R. S. WILHELM
for his paper on
"Rebuilding Old Plant Reduces Coal per Unit Output Nearly One-Half"

These selections represent the unanimous choice of the judges, and appear in this issue. Papers by the following authors received commendation and will be printed as space permits: James M. Bloomfield, J. F. Barkley, E. B. Strowger, E. M. Ayres, F. H. Poehlman, Charles Learmoth, C. A. Cutting, B. H. Blaisdell, J. H. Chalmers and C. A. Moulthrop.

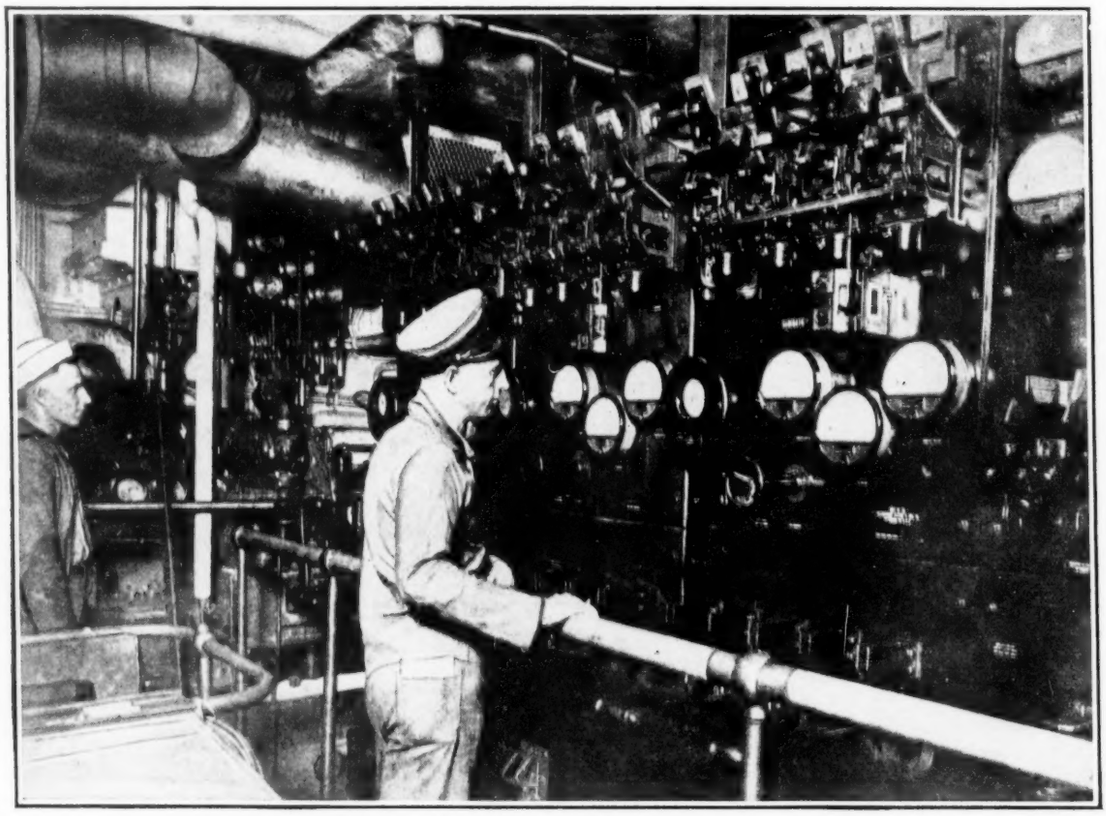
JUDGES OF THE CONTEST

R. J. S. PIGOTT
Consulting Engineer
Public Service Production Co.
Newark, N. J.

ALBERT C. WOOD
Consulting and Designing Engineer
Philadelphia, Pa.

F. M. GIBSON
Plant Engineer
American Sugar Refining Co.
Brooklyn, N. Y.

WINNER OF $500 FIRST PRIZE



One of the switchboards on the Colorado

Horsepower of the Mind

By LYBRAND SMITH
Lieutenant Commander, United States Navy

THE United States Battleship "Colorado" by improved operation raised its engineering efficiency 19 per cent during its third year, becoming the leading electric-drive battleship and taking a high place in the Navy's Engineering Competition.

That competition is on an efficiency basis. Each ship is assigned certain fuel allowances for various operations such as speeds underway, hours at anchor, raising steam from cold boilers, warming up engines, making exceptional amounts of fresh water, etc. One hundred times the ratio of fuel allowed to fuel used is the "Engineering Score." From this may be deducted certain penalties for such things as machinery derangements and failure to make speed. The remainder is the "Engineering Merit," which is a good numerical measure of the ship's engineering efficiency.

The "Colorado's" previous low standing in the Engineering Competition could not be attributed to poor material. On her official trials 37,400 hp. had been delivered to the propellers, and the main propulsion machinery, as well as all the auxiliaries, ranging from the six 300-kw. generators to the dentist's drill and the potato peeler, were in excellent condition.

Nor could lack of success be attributed to lack of personnel, either in quantity or quality. The engineering department of the ship had, on an average, sixteen officers and 350 men, all experienced and well trained. They were almost technically perfect in the operation of individual units of machinery.

Yet, the power plant did not operate efficiently as measured by the Engineering Competition. The "Final Merit" for the second year was only about 87 instead of around 100.

Why, then, did this new plant, in excellent material condition, with each unit well-nigh perfectly operated by trained personnel, have such a low efficiency? The answer is summed up in one expression:

Specialization Without Integration

N RECENT POWER CONTEST

Dr. H. W. Smith says: The evils too often attendant on specialization are universally recognized. . . . When each man is an authority only in his little corner, and is ignorant of all but a small part of the marvelously complex being he serves, intelligent service degenerates into purposeless tinkering and progress ceases by dispersion of its forces. . . . Paradoxically, the remedy commonly proposed for the evils resulting from specialism is the creation of yet another specialty, a super-specialty, that of the integrator or co-ordinator. . . .

COMMANDER SMITH entered the United States Navy as a Midshipman in 1907, graduating from Annapolis in 1911. He served continuously at sea in gunnery, engineering, navigational and staff duties until 1919, which period included the Mexican campaign and the World War. This was followed by duty with the military occupation of Santo Domingo. Following two years ashore as Commercial Superintendent of Naval Communication Service in Washington, he again was assigned to sea-duty and became Chief Engineer of the electric-drive battleship "Colorado." He is at present on duty in the Bureau of Engineering, Navy Department, Washington, D. C.

THIS presents the problem: By what means can the chief engineer increase his effectiveness as an integrator of the specialists within his department, and as a co-ordinator of his department with other departments?

The routine solution of the problem is reasoned argument and thorough planning. But used alone, they are futile. No human being is really moved to action by "reason." Apparently, the following holds good:

Whether men work to good purpose depends on moral judgment.

Whether men work efficiently depends on reason.

Whether men work at all depends on emotion.

You can use reason to determine the best methods of arousing emotion.

Reason is the cold, hard steel that is fabricated into the cylinders, pistons and pipes of the engine.

The steam without the steel is a dangerous uncontrolled force.

The steel without the steam is dead, is merely a museum curiosity.

The problem is to generate the emotion, to direct it to good purpose with moral judgment, and to control it efficiently with reason.

Thorough planning is necessary to administrative success. You can work out detailed plans for a target practice, for a full power trail, for a safety-first week or some short spectacular event. They will be thoroughly digested by every member of your organization and carried through to glorious success in a glow of enthusiasm. You can work out plans for a year's operation and even by pushing them like a slave driver you may have only indifferent success. When the plant runs twenty-four hours a day, 365 days a year, some of those hours are going to lack the spectacular element and with it that fine glow of enthusiasm. Some of those hours Specialist Bill is going to be a little too tired to co-ordinate with Specialist John.

ALL three judges, individually, and later, collectively, chose this paper for first place among the forty-four submitted. Although dealing with the power plant of an electric-drive battleship, the principle, in the opinion of the judges, has application to any power plant in demonstrating how the human equation can be applied to the co-ordination of effort in improvement of efficiency and general satisfaction in operation.—

Editor

Engineering can and should be made more spectacular. This can be done by posters, bulletins, graphs, articles in your "house organ," exhibitions, public recognition of special services, and so on. But that is not enough for fully vitalizing plans. The Chief must find or generate feeling in his men, organize it and make it an irresistible motive power

HUMAN ENGINEERING DEFINED

What is Human Engineering? One thing it is not. Human Engineering is not pulling the wires of marionettes, any more than mechanical engineering is pulling the wires of door bells. The Human Engineer is an "honest Injun" friend to his men. His is the science and art of selecting, training and using men, or of designing, constructing and operating organizations of men.

How can one acquire this? Just as one acquires any other art—by observation, reading, prolonged reflection and everlasting practice. There is listed here a representative bibliography that offers food for reflection and a guide to observation and practice.

Of what practical use is all this reading? None, if you just confine yourself to casual reading. But if you study and reflect on what you have read; if you make notes of important points and check these against actual observations of the behavior of men; if you make many trials in influencing behavior and try to correlate the causes of your successes and failures with what you have read—eventually it will become part of the cells of your own brain. It will affect all your dealings with men—to your benefit and theirs.

How were the principles as culled from such study applied to the engineer department of the "Colorado"? To answer that fully would require an intimate diary. In selecting men for jobs, it would show everything from formally analyzing their character-

istics on paper to getting personally acquainted while swapping a pipeful of tobacco in a fireroom. In training it would show everything from a formally prepared lecture to having new officers in the department perform with their hands duties ordinarily done by enlisted men. It would also show that each detail was hooked up to some emotion, and that emotion was in turn associated with one central feeling which by precept and practice was instilled into the entire personnel.

One central feeling, emotion or desire is the secret of integrating an aggregation of specialists into an organic whole.

There are several practical points in crystalizing such an emotion. To give it vigorous life, its object should be made perfectly clear. It should be summarized in a verbal formula that is easily recalled. Such a formula should be rather abstract or general, and should be applicable to the organization that uses it. It should unite its particular organization with allied and co-operating organizations.

If one stopped at this point, one would have nothing but a glittering generality. To avoid this, it is necessary to know the specific requirements of the general formula or mission, to know the methods of accomplishing these requirements, and to have some means of measuring success in accomplishment.

A Speech to the Engineer Force

The way these points were applied to the "Colorado" is best expressed by an abstract of a speech made by the author to the commissioned, warrant, and chief petty officers of the engineer department.

After a brief introduction which said that the leading assistants were entitled to know the policies of a new chief and that there would be no change in the engineering policies of the former chief, the main discussion dealt with four points, *Mission, Requirements, Methods and Measurement of Success*, according to the following outline:

"The Mission of our Engineer Department is *to render engineering service to the ship*. This may seem an obvious platitude, but it is not. If we were a repair ship, our mission would involve major repairs, the ship's gunners would have the mission of defending the repair engineers, and it would be up to the other departments to render service to us. If we were a big central plant ashore, our mission might well be "to generate power" and every other unit in the organization be subordinate to our needs. But on a battleship we have no excuse for existence except to serve the ship. Everything aboard a battleship is subordinate to the big guns. Only as we serve all departments, which in turn serve the big guns, do we justify our existence.

"The mission of our ship is to be an efficient fighting unit of the Fleet. The mission of the Fleet is to be an efficient naval force. The mission of the Navy is to command the sea for the Nation's defense. In serving the ship, we serve the Nation—we serve the interests of our families.

"The *requirements* necessary to accomplish this mission are properly treated under "Operation and Administration." Our requirements of operation are fourfold. We must provide energy in the form of power, heat, and light:

1. To move the ship at a finely controlled speed and course. (Main propulsion, steering engines, gyrocompass.)

2. To fight the armament. (Turret motors, ammunition hoists.)

3. To communicate within and without the ship. (Telephones, radio, searchlights, underwater sound.)

4. To live in health and comfort. (Light, heat, ventilation, refrigeration, fresh distilled water, boat engines, laundry machinery, electric bake ovens, doctor's X-ray.)

"The requirements of administration are threefold:

1. Material.—We must maintain and repair our own mechanisms and assist in the repair of others.

2. Personnel.—We must select, train and serve our men. Select the right man for the right job. Train him for that job and for promotion. Serve him so that he has a healthy, happy life and feels that the full force of his organization is behind him in time of personal trouble.

3. Records.—Keep 'reliable, adequate, and immediate records.' That is, be sure what you record is accurate; write enough, but do not clutter up records with useless junk; file what you have so that it is available for immediate reference and *then use it*.

"The *method* of accomplishing these requirements of operation and administration is Unity of command backed by organized brains.

"*Unity of command, operating alone, leads to the 'old man' type of organization. In this the Chief thinks he knows it all, and the subordinates either agree with him or are afraid to express their own opinions. So long as the Chief knows enough and retains his health and strength, his organization operates satisfactorily in his immediate presence. Organized brains, operating alone, lead to a 'co-operative society' where such action as may be taken is usually more intelligent than that of the 'old man' alone, but where little is done because no one person has the responsibility and power to decide that time for*

List of Books Recommended by the Author

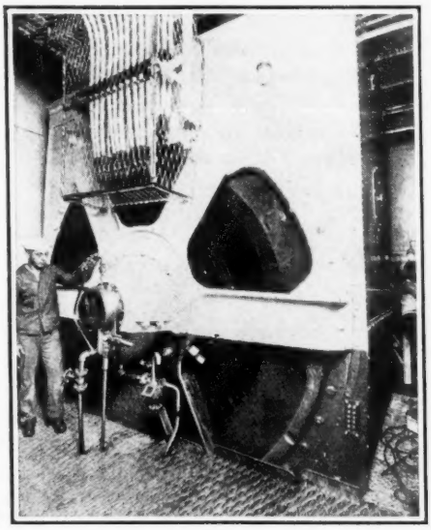
Influencing Human Behavior, H. A. Overstreet.
Influencing Men in Business, Walter Dill Scott.
How to Argue and Win, Grenville Kleiser.
Business Management, Lee Galloway (In Vol. II, Alex. Ham. Inst. Course).
Leadership, A. H. Miller.
Executive and His Control of Men, E. B. Gowin.
Preface to Politics, Walter Lippman.
Public Opinion in Peace and War, Abbott L. Lowell.
Biology of War, G. F. Nicolai.
How To Think in Business, M. T. McClure.
System of Logic, John Stuart Mill.
Real Business of Living, James H. Tufts.
Reconstruction in Philosophy, John Dewey.
Autobiography, Benjamin Franklin.
Il Principe, Niccolo Machiavelli.
Enchiridion, Epictetus.
Education of the Will, Jules Payot.
Learning Process, S. S. Colvin.
Mind in the Making, James Harvey Robison.
Outlines of Psychiatry, William A. White, M. D.
Fatigue Study, F. B. Gilbreth.
Psychology of Religious Experience, E. S. Ames.
Les Opinions et les Croyances, Gustave le Bon.
Behaviorism, John B. Watson.
Social Psychology, Wm. McDougall.
Why We Behave Like Human Beings, Geo. A. Dorsey.
Psychology, Everett Dean Martin.
Mankind at the Crossroads, Edward M. East.
The Revolt Against Civilization, Lothrop Stoddard.
Heredity and Environment, E. G. Conklin.
Inheritance of Acquired Characteristics, Paul Kammerer.
The Character of Races, Ellsworth Huntington.
Philosophy of Civilization, R. H. Towner.
Applied Eugenics, Paul Popence.
Genetics, Herbert E. Walter.

investigation and argument is past and time for action is due.

"Organization of brains requires two things—specialists with knowledge of their mates, and loyalty. My specialty, as Chief, will be knowledge of the whole plant and co-ordination with the other departments of the ship. I purpose to know more of this engineer plant *as a whole* than any other man. I expect each individual to have a more thorough and detailed knowledge of his own job than I have of that job. Heaven help any man if I find that I know more of his job than he knows himself. Loyalty works all ways—up, down and sideways. 'Loyalty requires a subordinate to stand up for his own opinions to his chief and for his chief's opinions to the world.'—Marshall Field. I purpose to back up my officers and chief petty officers whether they are right or wrong. If they are wrong, I will do my best to put them right privately and let them make any necessary public adjustment on their own initiative.

"Unity of command is necessary for prompt action. Organized brains are necessary for the most intelligent action. I purpose to avoid the evils and use the benefits of both.

"The *measurement* of *success* in our accomplishment is threefold: First, quantity of satisfactory service; second, economy of maintenance; third, efficiency.



Each of the four propellers is driven by a motor like this

"Quantity of satisfactory service is the most important, but unfortunately its measure is least definite. Almost the only thing we can do is to listen for the comments of people in the other departments. If they brag that 'our engineers can always do it,' that is a good sign. If they 'cuss us out' on any point, concentrate on overcoming that difficulty.

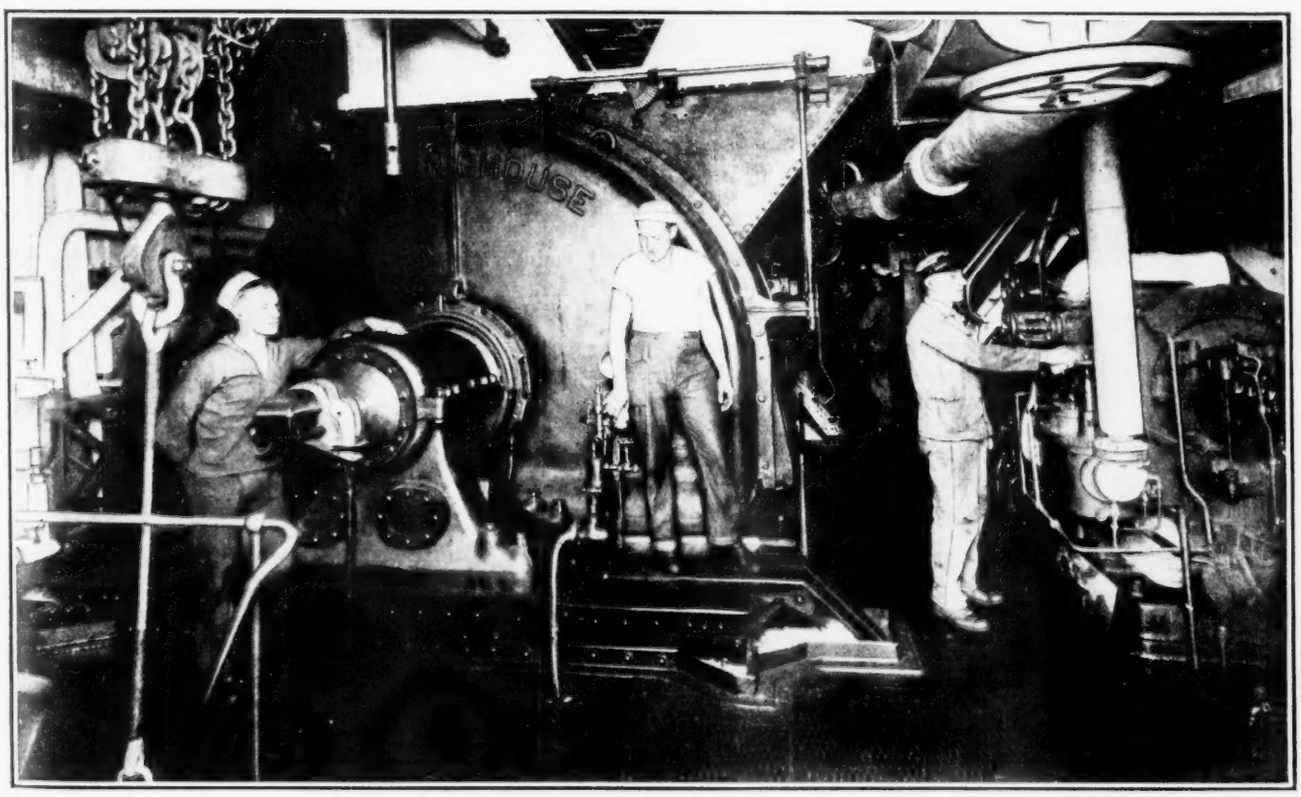
"Economy of maintenance is more definite. We have a good cost accounting system. A summary of that will be posted for all to see.

"Efficiency is the most definite measure we have. Efficiency is measured by our Score, and finally by our Merit in the Engineering Competition. Solve and post the score each hour. Find out what makes it go up and down. Then drive it up. Our goal is to be No. 1 battleship in the Fleet."

The Reaction and Follow-up

Did that speech take? It did. For once a group of the most influential officers and men had their thoughts directed in the same channel at the same time. The ideals were emotionalized. They gained power from the effect of group feeling. We had the nucleus of one central feeling which soon spread to the whole department. We integrated our specialists.

Of course, all that did not happen immediately. The speech was followed up. A suggestion here, an order there; a casual remark to a petty



There are two main turbine-generators and six 300-kw. sets (right) for auxiliary service

officer, an informal talk to a group; all these kept the emotion warm. Not everything said was believed at first.

What did happen immediately was a "cheering up" of all the leaders. This spread in ever widening circles until every man seemed affected. Specialist Bill began to co-ordinate with Specialist John—with or without orders—at noonday or in the middle of the night. Even the deck force finally were playing the game with the engineers. The movement grew like a rolling snowball. Men were happier and worked the machinery with greater efficiency and fewer derangements.

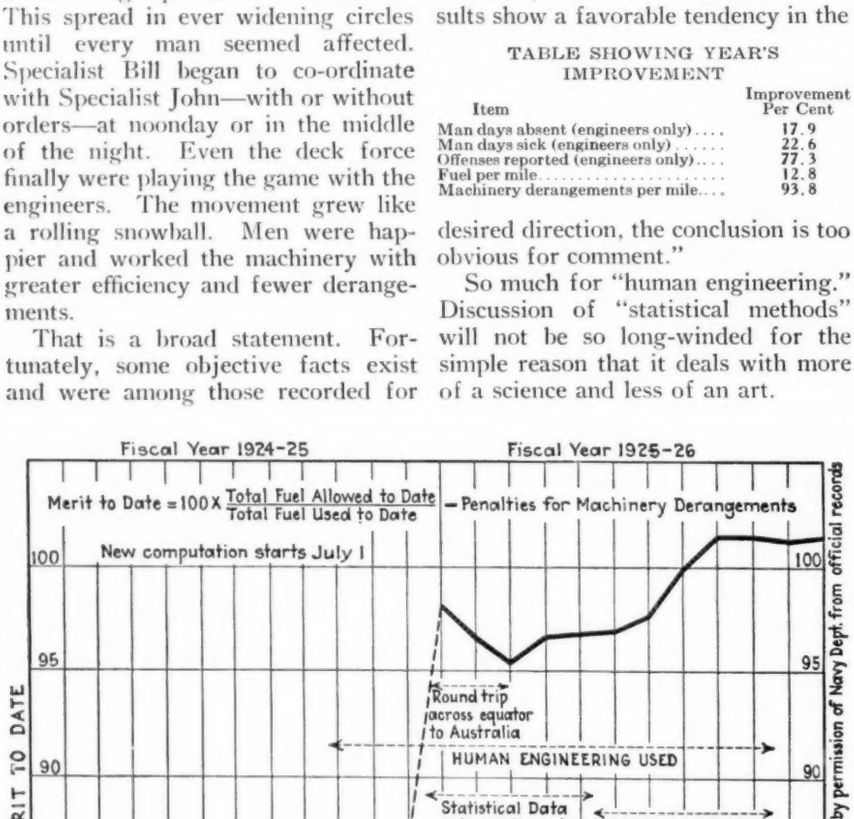
That is a broad statement. Fortunately, some objective facts exist and were among those recorded for a period of two years in a letter of the commanding officer. The speech inaugurating the new policies was the dividing point between the two years. In the former year we steamed 19,858 miles. In the latter year we steamed 35,478 miles under harder conditions. The average speed for one year was within three-tenths of a knot of that for the other. The following table is made by reducing pertinent figures from the commanding officer's letter to a basis which shows the year's improvement under the new policies measured by percentage reduction of unfavorable factors.

Quoting from the commanding officer's letter: "Any isolated event—or even any separate group of classified events—is susceptible of plausible explanation on grounds other than general policy and practice. But when a policy is adopted with the definite intention of exerting a specific influence, and when measurable results show a favorable tendency in the desired direction, the conclusion is too obvious for comment."

TABLE SHOWING YEAR'S IMPROVEMENT

Item	Improvement Per Cent
Man days absent (engineers only)	17.9
Man days sick (engineers only)	22.6
Offenses reported (engineers only)	77.3
Fuel per mile	12.8
Machinery derangements per mile	93.8

So much for "human engineering." Discussion of "statistical methods" will not be so long-winded for the simple reason that it deals with more of a science and less of an art.



Record of improved engineering efficiency, U.S.S. Colorado

The experimental method is the most powerful tool in the machine shop of science. There is no need to advocate experiment to any engineer. It is the marrow of his education.

But the experimental method begins to fail the engineer when he starts operations in real life. He no longer has control of all conditions. He is no longer confronted with one variable at a time.

Statistical methods cannot predict an individual event with the precision that experimental methods can in a laboratory. But statistical methods can predict the mean of a mass of events with astonishing accuracy. Moreover, statistical methods will give the probable error of this mean and the exact way individual events will scatter around it.

Possibly the greatest assistance of statistical methods is the ability to condense masses of data. Anyone who has seen presented to the engineer reams of paper covered with records of gage and instrument readings for each hour of the day, will realize that the only way he can get a clear-cut idea of what the whole thing means is to be a genius or to condense the figures. In that statistical methods stand pre-eminent.

No such library is needed to study statistics as to study human engineering. One good book is sufficient. The old standard classic is G. Udny Yule's "Theory of Statistics." But for the engineer several modern books are more suitable. Any one of the following is recommended:

Statistical Method—Harry Jerome.
Statistical Method—T. L. Kelly.
Statistical Methods—F. C. Mills.

These are excellent. That by Mills is probably the best for the engineer.

Statistical Methods Applied

The applications of statistical methods to the "Colorado" were too numerous to describe in full. But there were five particular correlations.

1. Port Fuel Consumption.—It is possible to "strike a heat balance" and make a good analysis of where each gallon of fuel goes. But the "heat balance" is a rather lengthy calculation and, consequently, is of little use in convincing people outside the Engineer Department that fuel should and could be saved.

A statistical analysis boiled down the whole mass of figures in the log to three observations per day and gave more accurate results than the "heat balance." It is against Regulations to publish figures which would disclose the actual fuel consumption of a Naval vessel, but that does not prevent publication of the type of formula obtained. It was this:

$$Y = a + bW + cK + dS$$

where

Y = Estimated fuel consumption per day
W = Gallons of water distilled per day.
K = Kilowatt - hours generated per day
S = Steam circuit hours per day
a, b, c and d = Constants derived according to statistical methods.

The facts were posted daily in a table like this:

Item	Amount	Multiplier	Estimated Oil
Water, distilled gallons	....	*b*	.....
Kw.-hr., generated	....	*c*	.....
Steam circuit, hours	....	*d*	.....
Constant	XXX	XXX	*a*
Total estimated oil burned	....	.....	.....
Actual oil burned	....	.....	.....

To indicate that the accuracy of statistical methods increases for a mass prediction, the following figures are given: For 15 days at anchor the calculated oil consumption was within $3\frac{1}{10}$ per cent of the actual. For 77 days at anchor the calculated oil consumption was within $\frac{8}{100}$ per cent of the actual.

For the engineers this formula did four things:

It established a normal standard for variable services rendered.

It attracted attention to plant efficiency.

It provided a basis for judging changes of material or operation.

It pointed the way to saving.

The most astonishing results were attained outside the Engineer Department. The simplicity of the table induced non-engineers to examine it. The cumulative effect was convincing of its accuracy. Then came a voluntary flow of practical assistance in cutting down fuel expenditure. The Supply Department scheduled cooking in the galley to get the same service with less steam-circuit hours. The Gunnery Department scheduled turret tests to reduce and level the load of kilowatt-hours. The first lieutenants went after waste of fresh water. Individual enlisted men made numerous practical suggestions. *We saved fuel at no expense to the service—because people were convinced that we knew what we were doing.*

2. Underway Fuel Consumption.—This was a correlation of speed and hourly fuel consumption. That corresponds to the "fuel allowances" for various speeds, mentioned in the description of the Engineering Competition. The curves of allowances are made by a rough statistical method. The difference between the allowance curves and the new curves is that the latter were produced by a more refined statistical method. They gave a more accurate prediction of what the ship would do. They also did what the allowance curves fail to do—they showed the theoretical scatter of individual observations around the normal curve, and thus gave a basis for judging whether any one hour's performance was abnormal.

3. Speed Handling.—Ships cruising in formation are required to maintain certain positions relative to a guide ship. Wind, waves, wake currents of other ships, etc., require frequent readjustment of speed to hold position. The manner of making changes of speed is one of the two most potent influences on the Engineering Score underway. It is perfectly useless to show officers-of-the-deck the record of their speed changes. The record is not only too voluminous for a busy O.O.D. to study, but also there is no obvious correlation between that record and the engineering score. By statistical methods, however, it was found that a definite correlation existed between the number of speed changes, the range through which they are made, and the engineering score. A single numerical measure of speed handling was designed and called the "Speed Handling Score." A graph of the hourly speed handling and engineering scores was posted daily. That the former score influenced the latter was convincingly apparent. A keen competition developed among the various officers-of-the-deck. As the speed handling score rose to new heights, the engineering score followed it, and fuel was saved.

4. Steering.—Steering is the other of the two most potent influences on the engineering score underway. Obviously, a rudder not amidships is a drag and will increase fuel consumption. To prevent the ship's yawing off its course, the helmsman must meet each yaw with the rudder. The best helmsman is the one who stops yaws while small with a small degree of rudder. Therefore, we built a rudder angle integrator which measured the average degrees of rudder angle used during the hour. This showed which helmsman was best. It did not show how much various helmsmen affected engineering efficiency. This last was determined by statistical methods. A score for steering was developed in a manner similar to that for speed handling.

5. Maneuvering.—Speed handling and steering combined are the two major factors that make up maneuvering from the engineer's point of view. How much weight should be assigned to each can be found by the statistical method. Even an approximate solution cut down fuel consumption an appreciable amount.

Did the plant efficiency improve under the influence of human engineering and statistical methods? It did. It was explained above that the Engineering Merit is a good numerical measure of the ship's engineering efficiency. The graph herewith shows how the Merit changed.

Increased Efficiency 19.6 Per Cent

From the graph alone one might deduce that the third year (1925-26) showed an increase from 86.959 to 101.251, or 14.292 over the year before. That would be a notable improvement, but we did more. The third year our allowances were cut down. We had to do much better to get a score of 100. To discover the absolute change in efficiency, the Navy Department works out an official "improvement factor" which takes into account differences in allowances, in speeds, in amount of time at anchor and underway, in machinery derangements, etc. If a ship breaks even, its improvement factor is 1.000. If a ship improves, its factor is proportionately greater. The third year the "Colorado's" improvement factor was 1.196. That means that *under the new methods we had increased efficiency 19.6 per cent.*

Human engineering and statistical methods were the mainsprings behind the details which caused the improvement. But even with a plant brought almost to mechanical perfection by the first chief engineer, these additional methods applied by his successor would have been nearly useless except for three things. Those were: The sympathetic understanding of the captain and executive officer; the whole-hearted co-operation of the heads of other departments; and the loyal friendship of the engineering officers and men.

The specific application of the principles of human engineering and statistical methods to the "Colorado" probably would suit only that particular ship at that particular time. *The general principles are applicable to any organization of men, in any business, at any time.*

Because the driving power for the whole train of events was based on mental reactions, and because the final result was equivalent to augmenting our physical power, it can be said that we liberated and used the "Horsepower of the Mind."

WINNER OF SECOND PRIZE OF $250

Power Cost per Ton of Product Cut to One-Third

By Improvements Which Will Return Investment in Three Years

By ROBERT S. BAYNTUM

How this was accomplished at the paper and pulp mill of the Chesapeake Corporation at West Point, Va.

PROGRESSIVE improvements carried out at the mill of the Chesapeake Corporation during the last few years afford an interesting and instructive example of the economies that may be obtained by correct design and a sound knowledge of the basic principles involved, when backed up by a progressive and financially courageous management.

Following the War the mill had changed ownership, and it was fortunate for the new shareholders that at the head of affairs had been placed one of the leading pulp mill experts of the country, who had an intimate acquaintance not only with the technology of the processes involved, but also with the engineering aspects of the situation. The plant engineer who works under such management is at least sure of getting a fair hearing and judicial weighing up for any plans of improvement he may bring forward.

Under the new management the production increased by leaps and bounds, and the problem of supplying sufficient power and of reducing its cost became a pressing one.

The improvements that were put in hand may be divided into two main groups, the first of which covers the initial economies effected by rearranging the steam-using apparatus of the mill, thereby improving the heat balance and saving exhaust steam previously rejected to the atmosphere, with little expenditure of additional capital.

Having done all that could be managed in this direction, it became necessary, in view of the age and insufficiency of the old power plant to meet the demands for increased production, to consider whether to extend the old plant or to build an entirely new one on modern lines.

After a rigid investigation of all the possibilities it was decided to go ahead on ultra-modern lines, with the result that a plant was installed that is almost unique in the paper mill industry.

ROBERT S. BAYNTUM was born in England, received his technical education at Bristol and was employed on various public utilities in that country until the outbreak of the War, at which time he joined the Royal Engineers. While in England he was a member of the Institution of Civil Engineers, Institution of Mechanical Engineers and Institution of Electrical Engineers. At the close of the War he came to this country, and after holding some temporary positions, was appointed chief engineer of the Chesapeake Corporation. He lately joined the Rust Engineering Co. at Pittsburgh.

Space forbids more than a brief résumé of the earlier group of improvements, which, moreover, having been put into effect some years ago, are superseded in interest of those obtained in the new plant, but the diagrams that accompany this article give an idea of their magnitude and nature, and the following details indicate briefly how they were effected.

1. Excess steam from the board mill driers, which had been rejected to atmosphere, was used to supply the pulp mill evaporators, which were previously supplied from the high-pressure line through reducing valves.

2. Steam from digesters, blown to waste, was used in a surface condenser to heat water for the digesters.

3. A non-condensing engine, which had been used to supply steam as mentioned in the preceding paragraph, was replaced by a condensing turbine.

4. Motor drive was substituted for steam-engine drive to such an extent as to eliminate as nearly as possible blowing exhaust steam to atmosphere.

5. A 1,500 sq.ft. boiler was installed for burning the sawdust and bark from the pulpwood. This gave additional steam besides saving the cost of carrying away the trash.

6. Complete heat insulation of large pressure vessels minimized the loss of heat from this source.

7. A careful check was kept at all times on the back pressure at which the various engines operated when exhausting into the driers, with the object of keeping this at a minimum consistent with the necessary degree of drying, thus reducing the steam consumption of the engines.

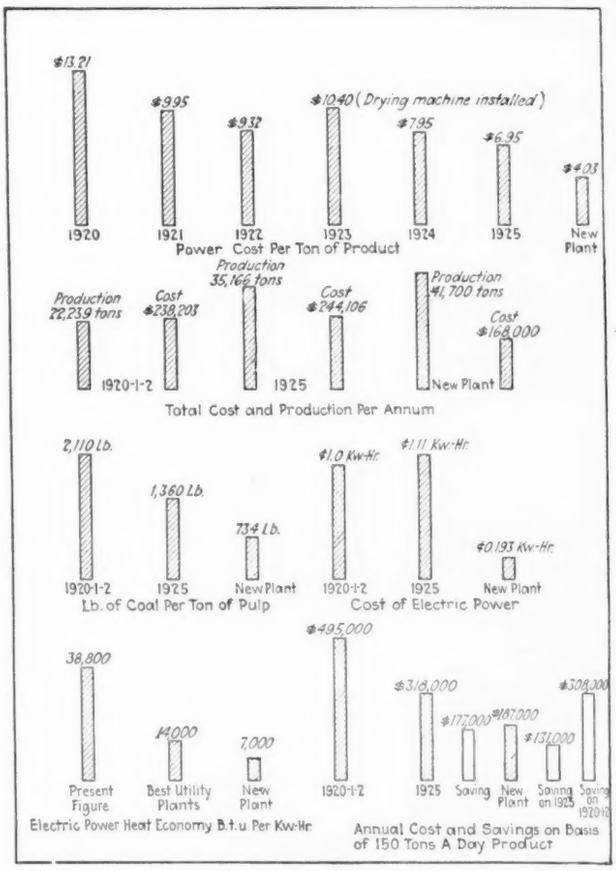
The total cost of making these alterations was less than $30,000, and the saving effected per annum was greatly in excess of this figure, as may be seen from the charts.

While the changes indicated above had effected great economies, the increasing production made demands on the plant beyond its capacity, and it was, therefore, decided to get out designs for a complete new power plant, retaining only such parts of the original installation as could be worked into the new arrangement without sacrifice of efficiency and having it in view to obtain the maximum possible savings by pushing the use of modern methods to the utmost limit consistent with reliability and economy of capital expenditure.

The old plant contained two turbines of 750 and 500 kw., and there were in the mill four engines of 100 to 400 hp., the exhaust steam from which was usefully employed for process work. There were seven coal-burning, water-tube boilers totaling 22,000 sq.ft., and one of the return type used for burning bark and chipper dust.

It was planned to install sufficient new boilers to deal with the whole load of the mill after making provision for a desired increase of output of about 20 per cent, scrapping all the old boilers except that used for refuse disposal, and to rearrange and partly renew the prime movers.

The 500-kw. turbine was dropped and one engine was replaced by motor drive, for heat-balance improvement. The old site being crowded and otherwise unsuitable, it was necessary to provide entirely new buildings on a fresh site and to install a coal handling and storage plant.



Comparative costs broken down

Selection of Steam Pressure

Almost the first point to be determined in the development of the design was that dealing with the selection of the most desirable pressure and superheat for the steam. It is necessary to bear in mind that at the time these investigations were being made (early in 1925) the range of choice as to steam pressures and available turbine efficiencies was more limited than is the case at present, the progress since that time having been very marked as a result of the satisfactory operation of such plants.

The pressure and superheat of the steam supply which will afford the greatest operating efficiency is determined by calculation from the normal demands for electrical power and medium-pressure steam, and the available efficiencies of the back-pressure turbines. The method followed in this particular case was to set down the individual minimum, average and maximum demands for steam and power for each department, and assuming the severe condition that all the minimum demands might occur simultaneously, and that likewise all the maximum demands might come on at the same time, obtain thus the range of variation in the amount of steam to be supplied.

By this method it was found that the total net demand for 130-lb. steam would under ordinary conditions vary from a minimum of 59,000 lb. per hour through an average of 72,000 lb., to a maximum of 86,000 lb. From the average of 72,000 lb. per hour an electrical power of about 1,180 kw. should be obtained at a very low cost. Under exceptional conditions the variations would exceed these limits, but these could be taken care of by special arrangements provided in the design.

Careful research is necessary to ascertain the lowest pressure it is possible to select for satisfactory operation of that portion of the plant which it is proposed to retain, and the amount of superheat that can safely be allowed in the supply must also be settled. The Rankine efficiency that can reasonably be anticipated for the high-pressure turbine must be determined, and with all these factors in view, a series of calculations should be made to find the power available from the steam while being reduced from the various high and medium pressures and superheats to the selected exhaust pressures, and the condition of the steam at exhaust. In the present case a Rankine efficiency of 57 per cent was assumed, which was afterward found to be closely in accordance with that offered by the turbine makers for the actual machines, and calculations were made for pressures between 275 and 550 lb. by steps of 25 lb., and for superheats of 50 to 200 deg. by steps of 50 degrees.

It was found that for the average steam and electrical demands that would exist in the new plant after the extensions in hand, and for the increased production, the best steam conditions were 425 lb. pressure and 100 deg. superheat; and that, assuming such conditions, an almost perfect heat balance for the entire plant could be obtained during average running and maintained over a reasonably wide deviation from the normal, while at the same time provision could be made to cope with all emergencies and unusual conditions.

Having decided to install high-pressure boilers, it became necessary to take steps to insure pure feed water, for with such pressures priming dangers are increased. A further point to be taken into consideration

was the high alkaline nature of the makeup water. Again, it had to be remembered that it was proposed to run the boilers under certain circumstances at high ratings.

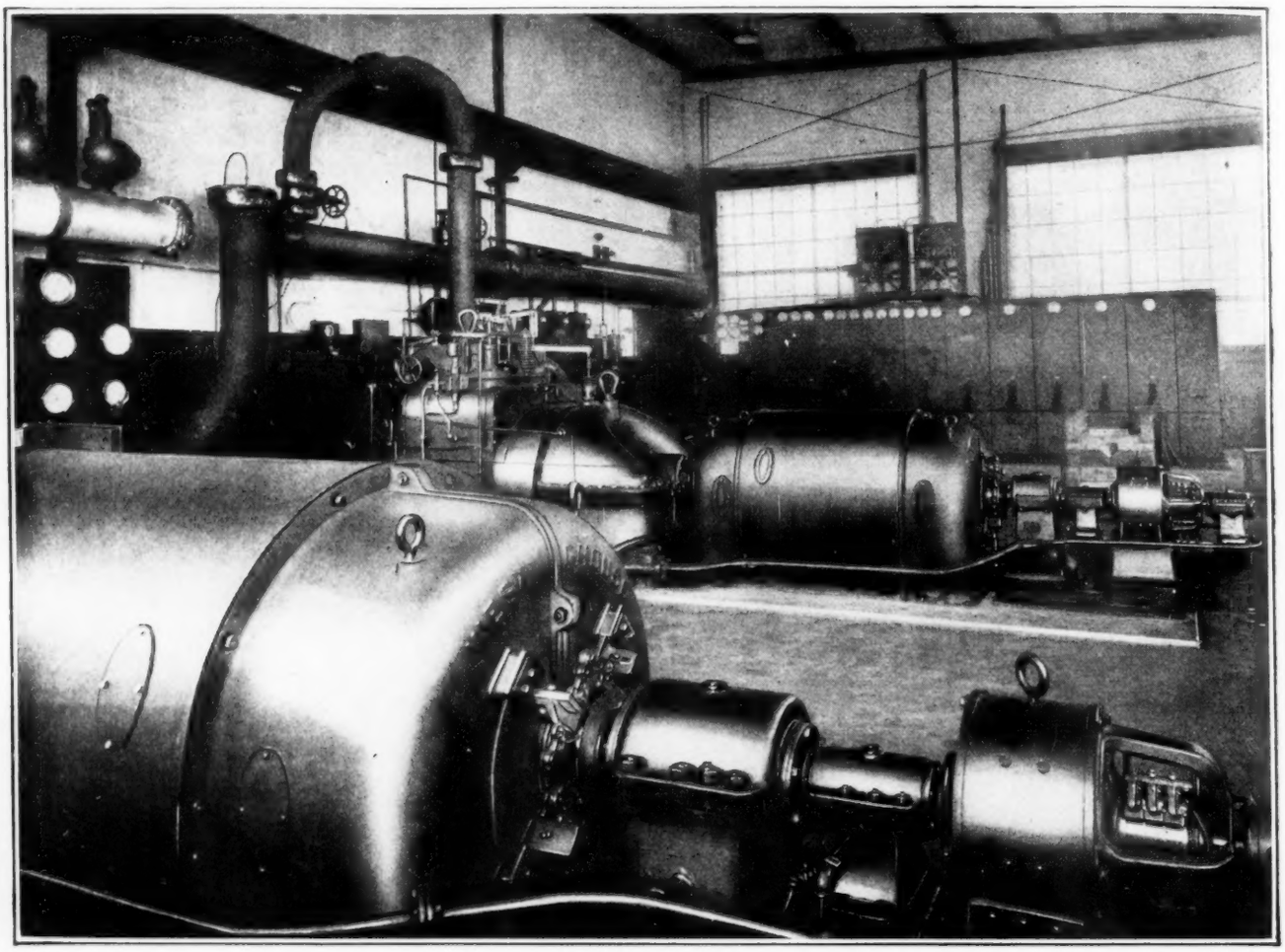
The alkaline nature of the feed water made suitable treatment a matter of some difficulty, and while it might have been possible to find a number of systems that would more or less offer a remedy, it was felt that the only reliable method of getting perfectly pure water for the boilers was by the employment of evaporators for the whole of the makeup. This at once raised a serious problem of economy. The proportion of makeup is very high, averaging 20 to 25 per cent, on account of the use of steam in process work, and it became essential to find a method that would involve the minimum of thermal loss coupled with the minimum degradation.

Inquiries from two leading manufacturers of such apparatus evoked nothing better than in one case the suggested use of exhaust steam for the evaporators and in the other case the installation of a single-effect evaporator, taking steam from the 425-lb. line and exhausting into the medium-pressure header at 130 lb. The first plan involved the loss of a large amount of heat which could be profitably employed elsewhere without rejection of heat to the condenser. The other plan, while subject to little thermal loss, did involve a serious degradation of heat—a loss of availability of heat units which were required to give power.

The failure of the evaporator makers to bring forward any suitable scheme left it up to the author, who finally evolved a plan whereby losses were reduced to a minimum, and the evaporator plant, instead of being a source of loss, was put in the position of returning considerable revenue for the capital expended. The plan was, briefly, to install a three-effect evaporator taking steam from the 130-lb. line, which had already done work in the high-pressure turbine, and condense the vapors from the third effect with the boiler feed water, thus recovering all the heat units, and carrying them back to the boilers, and also permitting about 160 kw. of electrical power to be extracted from the steam on its passage through the high-pressure turbines.

It was found that the feed water would leave the evaporator high-heat level condenser at about 260 deg., and a further improvement in the feed system was made by the addition of a stage heater, taking steam from the 130-lb. header, which would raise the feed temperature to 350 deg. and allow of the generation of a further 70 kw. of electrical power from the steam necessary for the purpose. This alone would result in an economy of about 2 per cent of the coal bill at a trifling cost.

The question of pure feed being thus satisfactorily settled, the next problem to be faced was that of the extraction and utilization of all pos-



Turbine Room of Chesapeake Corporation

sible heat from the flue gases. Economizers were regarded with disfavor from the first, since one of the points aimed at was to have as small an amount of piping and apparatus as possible under the high pressure, and they were rendered impossible by the arrangement of the evaporator plant. This obviously called for air preheating, and to obtain the greatest efficiency and turn the gases out to the stack at a reasonably low figure (260 deg. was the temperature finally arranged) it was decided to install air preheaters of such a size as would deliver the air to the furnaces at 400 to 450 deg.

Description of the New Plant

The building is conveniently situated at the southeast corner of the mill and is of steel-frame and hollow-tile construction, stucco-covered from the firing floor up, this floor being placed 12 ft. above ground level. The basement is used to provide space for ash hoppers of such capacity as will permit the ashes formed through the night to remain till the next day, to be removed by the two men who handle all the coal and the ashes from both shifts. Two men thus replace nine under the old system. The evaporators, feed pumps and other auxiliaries are also placed in the basement. The construction below the firing-floor level is of reinforced concrete throughout.

There are installed three 494 sq.ft. Walsh & Weidner boilers operating at 425 lb. steam pressure, with Foster superheaters giving 100 deg. superheat. The installation includes Westinghouse five-retort, 18-tuyere, underfeed stokers designed to burn coal of 13,750 B.t.u. and 10 per cent ash, and permitting of 300 per cent rating on the boilers, but it is proposed that the normal rate of operation shall be only 200 per cent for maximum economy and to minimize trouble with refractories.

The air preheaters are of the Ljungstrom rotary pattern, and they have to their credit the excellent performance of supplying air to the stokers at 450 deg. while passing the gases to the stack at 240 deg. The forced and induced-draft fans are integral with the heater and are mounted on the same shaft and driven by a 100-hp. G.E., slip-ring motor, with rheostat control. The air preheaters are installed on the top of the boilers instead of being in the more usual position at the back, and the whole of the top of the boiler room, which is distinct from and higher than the turbine room, forms a closed box, so to speak, whence the fans draw their air. The consumption of air is such that at normal loads the whole of the air in the boiler room is drawn through the fans in five minutes, and thus there is continuous circulation. The possibility of recovering most of the heat lost by convection and radiation from the settings has been taken advantage of by the use of hollow, ventilated side walls. This should, by the cooling effect on the furnace linings, improve the life of the refractories, and is diametrically opposed to the more usual practice of placing special heat-insulating bricks to keep the heat in. Diamond "Valve-in-Head" soot blowers are installed, taking steam from the 130-lb. line; this steam also has already done work in the high-pressure turbine.

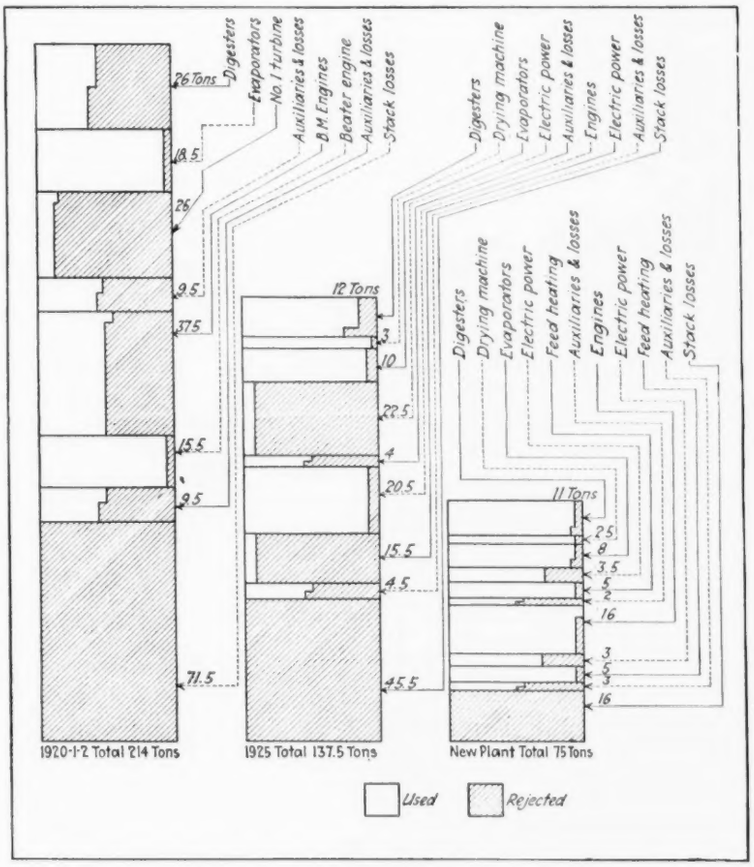
Bailey boiler meters, pyrometers and draft gages are fitted to each boiler, and a check is afforded by a Brown electrical CO recorder, which can be switched to any boiler. Flow meters are placed in the principal steam lines for the correct apportionment of the costs.

Hagan control is installed to regulate the fan speeds according to the steam pressure and to maintain a suitable draft over the fires.

A three-effect evaporator plant, of the Griscom-Russell high-heat-level type, was installed.

The boiler-feed pumps, two in number, are five-stage centrifugals of Cameron type and of heavy and rigid construction. Each is capable of delivering 240 gal. a minute against a head of 1,100 ft. They are arranged for dual drive, normally by electric motor, the work being automatically taken over, in the event of any failure, by a Westinghouse steam-turbine supplied from the 130-lb. line.

Copes tension-type feed-water regulators with pump governors are installed, and the feed range is run in a modified ring system, for security of supply. The piping is of pure iron, to minimize corrosion. It was supplied and erected by the Pittsburgh Piping & Equipment Co., who



Distribution of heat and coal required for producing 150 tons of product (50 tons dry pulp, 50 tons board, 50 tons wet pulp) under (a) original conditions, (b) 1925 conditions, (c) with new plant

also installed the high-pressure steam lines, these being jointed throughout with "Sargol" welded flanges, except that the valves are left free for easy removal in case of necessity. The evaporator piping system for steam and water was supplied and erected by the Grinnell Company, and the remainder of the piping by the construction staff of the mill.

The coal- and ash-handling equipment, constructed by the R. H. Beaumont Co., is of simple design but calculated to give a maximum reliability of supply with a minimum of labor cost. It consists of a track hopper and automatic feeder leading to a double roll crusher and chain conveyor, taking the coal up to a 150-ton circular, steel-plate bunker, placed outside the boiler house. A traveling weigh larry is used to convey the coal to the boilers. Considerable saving in capital cost was effected by the adoption of this form of storage over the more usual method of placing an overhead bunker in the boiler house. Ground storage is used to provide a supplementary supply of coal.

Water storage is provided by three 18,000-gal. circular tanks, placed on an elevated concrete structure adjacent to the coal bunker.

The buildings and foundations, with the stacks, flues, air ducts and boiler settings, were designed and constructed by the Rust Engineering Co., which also provided the labor for the erection of the plant.

Reducing Valves and Desuperheater Connect Two Systems

In order to provide for exceptional conditions, when the supply of 130-lb. steam from the high-pressure turbine, owing to a temporary falling off in the demand for electrical power or an abnormal demand for low-pressure steam, should be insufficient, a complete reducing valve system in duplicate has been installed. On the outlet a manifold with four safety valves is installed, to protect the medium-pressure line, and from that the steam is led through a 14-in. surface-type desuperheater, water for which is provided by a pump having a capacity of 12 gal. a minute, with automatic start and stop. Water for this purpose may also be drawn from the feed range, through reducing valves.

The turbine room is designed for three turbines. The one high-pressure unit is a 1,500-kw. Westinghouse high-back-pressure machine taking steam at 420 lb. and 100 deg. superheat, and exhausting at 130 lb. to the medium-pressure steam header. This is coupled to a 550-volt three-phase 60-cycle generator running at a speed of 3,600 r.p.m. At full load the contract water rate is 60 lb. per kw.-hr., and at 1,000 kilowatts it is 61 lb. The other new turbine set is a medium-pressure bleeder and condensing set of 750 kw. capacity, taking steam at 130 lb. and 50 deg. superheat, with a water rate condensing of 17 lb. per kw.-hr. It has been specially designed for maximum efficiency as a bleeder unit, as it is not expected to reject more than a small proportion of the steam to the condenser. The conditions of parallel running of these sets have already been considered.

A third set is provided by the existing General Electric 750-kw. turbine, which has been moved from its old site in the plant and re-erected in the new turbine room. This will permit of running the two 750-kw. sets on low pressure, in the event of the high-pressure unit being out of service, and thus of keeping the greater portion of the mill in operation.

The switchboard, of Westinghouse design, provides for three generators and six feeders. A voltage regulator to control the generators has been installed. All the oil switches are in the basement, and ample room is provided for access to all parts.

Savings Effected and Comparative Figures

The following calculations and comparisons are based on a standard output of 150 tons of product a day, both for the old plant and for the new, it being thus assumed to facilitate comparison that the old plant would have been extended on the same lines to enable it to cope with such an output.

The guaranteed combined efficiency of the boilers, superheaters and air preheaters, with the stokers as installed, is 85 per cent. The author assumed as a basis of calculation a 24-hour efficiency for normal running of only 78 per cent, being desirous of avoiding all appearance of overestimating the saving to be made. At the same time the efficiency for the old conditions, being taken at 67 per cent, was certainly not on the low side, as the net estimated improvment from 67 to 78 per cent, in substituting the most modern equipment for the old out-of-date and overworked plant, is conservative.

On the foregoing lines the daily coal consumption would be 68 tons, and allowing 32 tons for week-end running and losses, the coal used weekly would be 440 tons. The annual cost would be $108,000. Similarly, for equal production, the old plant would annually consume coal to the value of $200,000, the saving on this item being $92,000 per annum. It is estimated that a further saving of $11,000 per annum will be effected by burning a cheaper grade of fuel, as the old plant required coal of the highest possible quality and correspondingly high price.

The repair bill to the old boiler and stoker plant was excessive, and a moderate estimate has been made of saving 60 per cent of the expenditure on those items, reducing it from $30,000 to $12,000 per annum—a saving of $18,000.

The staff for the old plant has been reduced by 14 men—firemen, ash rollers and coal passers—with a net saving of $20,000 per annum.

Comparative Costs on a Basis of 46,800 Tons Annual Output—On the above lines the power cost for the new plant would be $183,500 per annum, whereas, for the old plant extended on existing lines, it would be $300,000 per annum—a net saving of $136,500 per annum.

Capital Costs—The estimated cost of extending the old plant to cope with the desired increase of output was $80,000. The new plant has cost under $350,000 so that the whole capital will be returned in less than three years.

The following figures afford some comparisons of interest:

POWER COST PER TON OF PRODUCT

Old Plant, 1920	$13.21
Old Plant, rearranged, 1925	6.95
New Plant, estimated	4.05

COAL PER TON OF PULP

1920	2,110 lb.
1925	1,360 lb.
New Plant	734 lb.

COST OF ELECTRIC POWER

	Cents per Kw.-Hr.
Old Plant	1.00
New Plant	0.19

The new plant was put into operation in September, 1926, and the results achieved are encouraging.

All indications go to show that the estimate for savings will actually be exceeded for the year 1927, which, in view of their magnitude, must be rated as eminently satisfactory.

The heat-balance diagrams and column charts appended illustrate the improvements made in the conditions by the changes indicated.

WINNER OF THIRD PRIZE OF $100

Rebuilding Old Plant

Reduces Coal per Unit Output Nearly One Half

Capacity Increased Ten Times in Practically the Same Building

By R. S. WILHELM

IN MAY, 1925, the reconstruction of the Bay Front steam station of the Lake Superior District Power Co., at Ashland, Wis., was completed to its present capacity, which, by change in equipment and consequently better operating methods, reduced the original coal consumption of about 3.33 lb. to 1.9 lb. per kilowatt-hour.

The original installation was made in 1915 and consisted of three 500-kw. vertical Curtis turbine-generator units, with surface condensers. All boiler-feed and service-pumps were steam driven and were located with the feed-water heater in the condenser room underneath the turbine floor.

Four 3,500-sq.ft. water-tube boilers of the sectional-header type without superheaters, were installed and were fired by overfeed stokers with Dutch oven settings. No provision was made for coal or ash handling, and the coal was brought in by wheelbarrows on a plank runway and dumped into the stoker hoppers about 8 ft. above the boiler-room floor level.

The ashes were taken from the pits under the stokers with long-handled shovels and conveyed to the pile 100 to 250 ft. from the boiler room by the wheelbarrow route. No pretense of checking the operation was made and no instruments other than steam gages were provided, except that watt-hour meters were on the switchboard. No regulators or mechanical soot cleaners of any kind were provided with the original equipment. The steam pressure was 155 lb. gage, when the coal heavers could handle enough coal to enable the fireman to keep the steam pressure at normal, and occasionally they managed to do it.

In 1916 the war load began pinching and some hurry-up changes had to be made without giving much thought to the future. The switchboard was jacked up about three feet and shoved toward the south wall of the building to obtain sufficient space to crowd in a 5,000-kw. horizontal turbine-generator set.

R. S. WILHELM was born in Franklin County, Indiana. His first experience with steam plants was as a boy around the boilers and slide-valve engines in his grandfather's mills at St. Leon, Ind. For nine years previous to 1912 Mr. Wilhelm obtained a wide experience in the operation, construction and testing of plants. This experience included not only steam stations, but also refrigeration and gas plants. In May, 1912, he became chief engineer for the Marquette Gas & Electric Co., where he remained until April, 1918. A transfer made him chief engineer of the companies which later became the Lake Superior District Power Company, and for which he is now chief engineer of power stations.

In the boiler room two 5,700-sq.ft. boilers were installed, of the same type as the original boilers, except that the latter had flowed steel instead of cast-iron headers and were equipped with superheaters. These two boilers were served by a new reinforced-concrete stack, erected outside the boiler room; its capacity and arrangement were such that it could serve future installations. The two boilers were fired by similar stokers and settings as the original. Coal bunkers with a Monorail man trolley and grab bucket were installed in 1917, and this made possible the handling of coal from cars directly into the bunkers.

During periods of heavy load poor steam conditions prevailed, and no instruments for checking operation had been installed. In 1918 some steam-flow meters, draft gages and mechanical soot cleaners were put into service and the coal per kw.-hr. was reduced from 3.33 to 2.7 lb.

In 1920 it was decided that there was a future for electric power in this community and plans were started to meet the demands, and in the early part of 1921 a designing engineer was employed to work out and bring to a decision how the increase in capacity should be obtained.

The advantages of the power station in its location, as originally installed and reconstructed are about as follows:

1. As fine a location for unlimited good condensing water and boiler

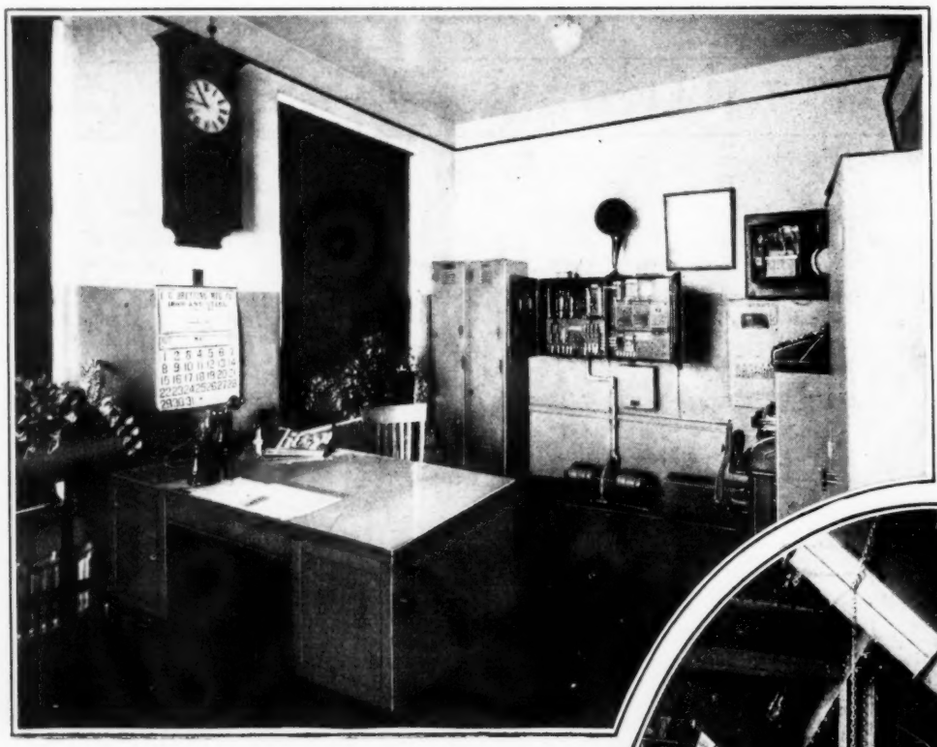


Fig. 1 (Left) — Chief engineer's office, showing the carrier-current telephone set and the graphic frequency meter and voltmeter

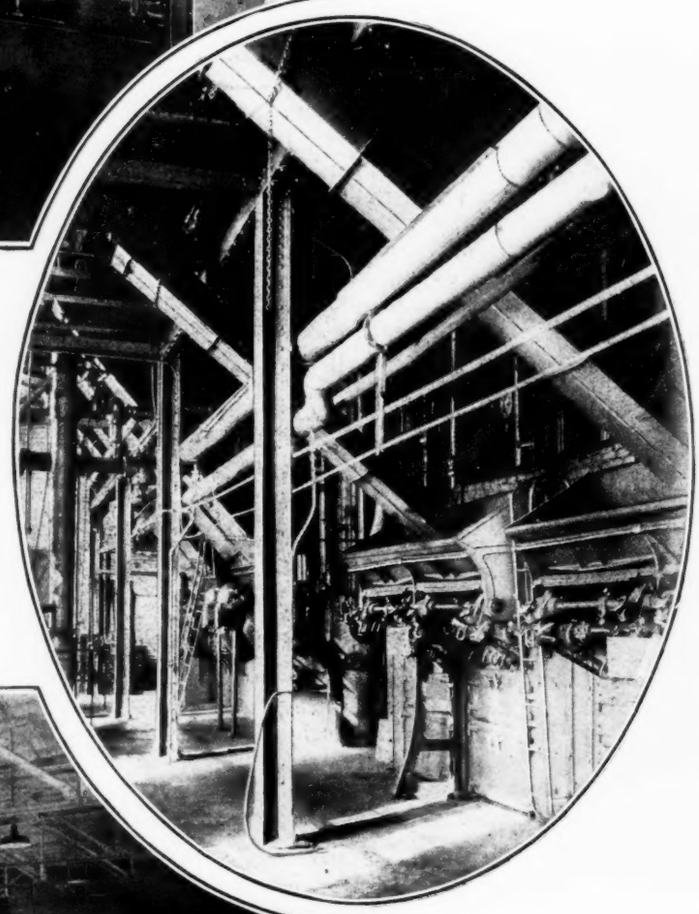


Fig. 2 (Right)—Boiler room with two 5,700-sq.ft. boilers installed in 1917 and two 5,500-sq.ft. boilers installed later, with underfeed stokers. In this installation coal comes to the stokers from an overhead bunker and the ashes are removed by a steam-jet conveyor

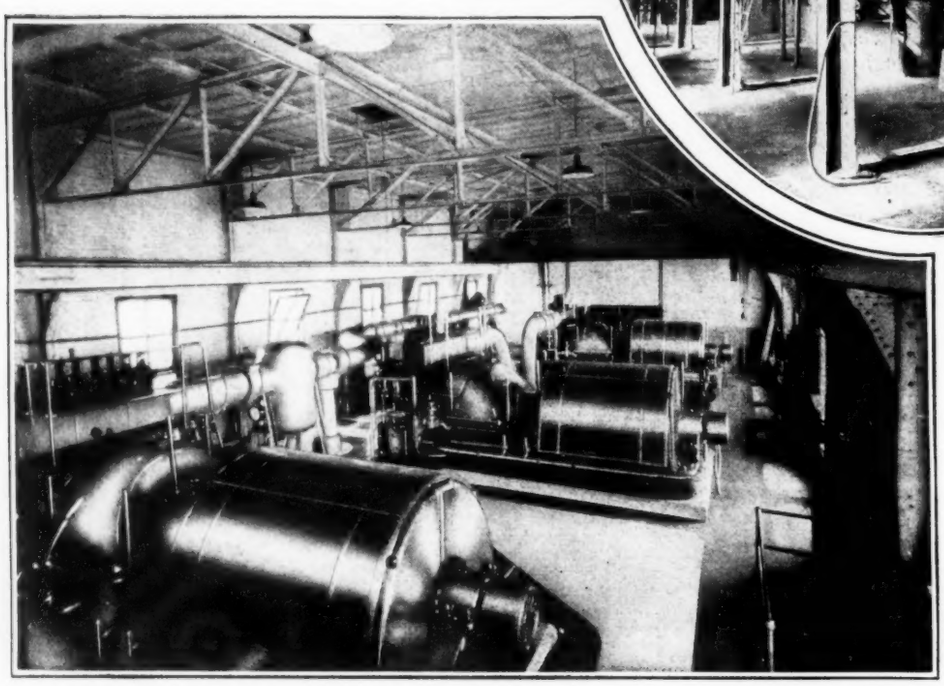


Fig. 3 (Left) — Rebuilt turbine room with three 10,000-kw. units installed

feed water supply as can be found anywhere.

2. Ready access to three large coal docks, receiving coal by lake transportation, connection with four railroads, some connecting with other Lake ports and the possibility of Lake boats being able to dock and unload at the plant should it be desired to do so.

3. Excellent field for power load, created by mining industry on the Gogebic Iron Range.

4. Good labor conditions.

The disadvantages of reconstructing and improving this station, in its original location were:

1. Shortage of space within the building, which was of poor layout originally.

2. The entire site was built up of wood slabs from a depth of 8 to 14 ft. and extended into the Chequamegon Bay.

3. The removal of a reinforced-concrete stack, originally erected within the boiler room.

4. The removal of the massive concrete foundations, which were improperly reinforced when built for the original installation.

5. The necessity of having to drive piling in close working distances of lines operating at from 2,300 to 33,000 volts.

6. The difficulty of getting the larger equipment into the allotted space without dismantling it.

7. The necessity of supplying uninterrupted service, under heavy-load conditions, while construction was in progress.

8. The practical impossibility of installing coal weighing apparatus on account of prohibitive cost under the conditions.

The advantages were outstanding and were not questioned. The first disadvantage was overcome by making floor-plan drawings to scale, of all equipment installed, as well as of proposed future equipment. Also floor plans were made of the entire building and all piles were checked and located exactly on these plans. The floor plans of the proposed machinery were then cut out exactly and moved around on the drawings, to determine possible location, as to piling support, installation, inspection, maintenance and dismantling possibilities, and by so doing, it was found that the ultimate capacity, within the then erected building, could be made 15,000 kw. by making a small addition on the south end for the circuit breakers and bus room, the second floor of this extension serving for the chief engineer's and load dispatcher's office.

At the north, or boiler-room, end of the building a small addition would also have to be erected to house a machine shop, forge shop and storage for spare parts, which must be kept on hand. This addition also houses the wash, toilet and locker rooms for the employees.

Drawings of different boilers were considered and made, as well as of the tubes, and it was found that a certain bent water-tube boiler had considerable advantages in fitting into the plans, as to space for tube removal. Complete removal cost of the old equipment was figured and compared with the cost of separate new con-

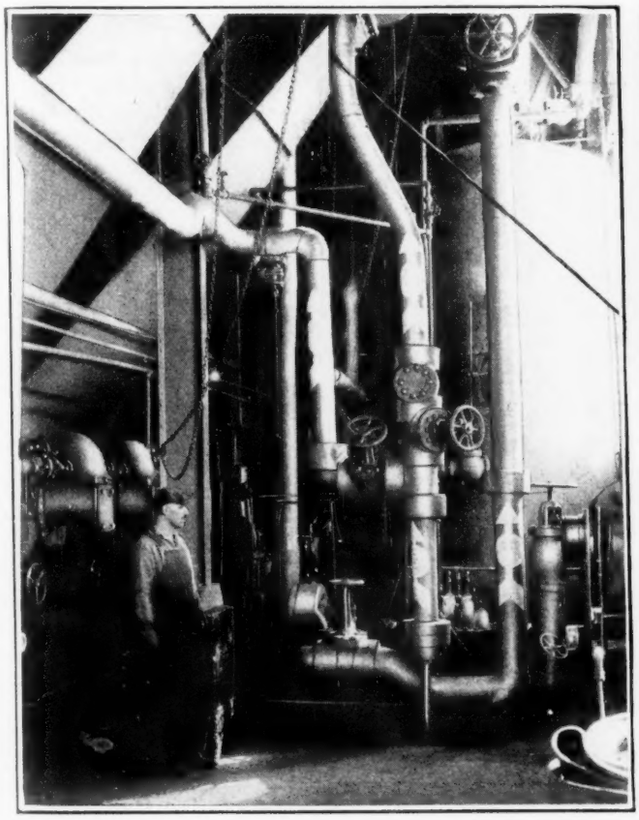


Fig. 4—Boiler-feed pumps and feed-water heater on firing aisle floor

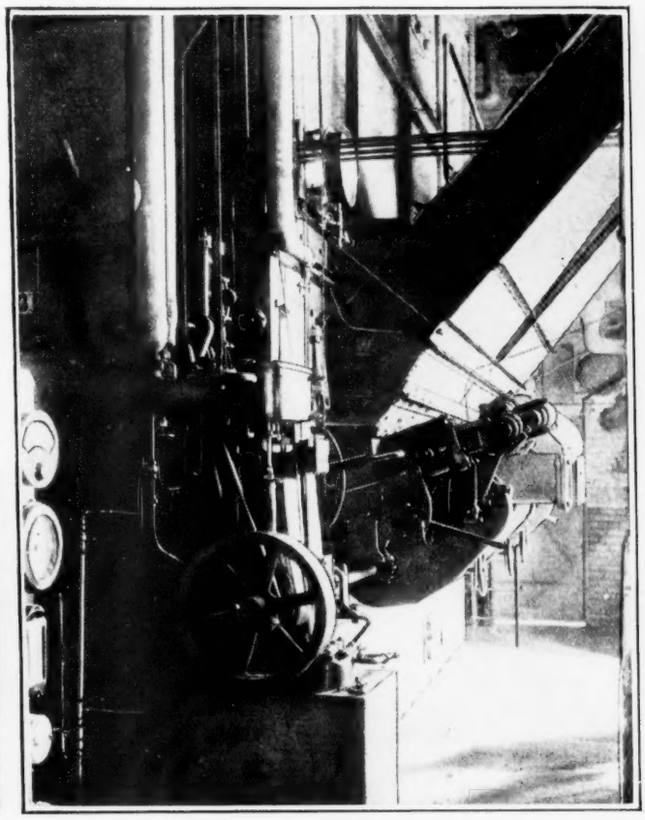


Fig. 5—One of the stoker engines; flywheel guard removed before taking picture

struction, also each move was definitely planned so as to avoid service interruption. The detailed data showed very much in favor of retaining the original building up to 15,000-kw. capacity, and it was, therefore, decided that reconstruction and additions to the original capacity be started.

The installation of the second 5,000-kw. turbine-generator unit and two 5,500-sq.ft. boilers, with underfeed stokers and forced-draft fans was planned and started and the work completed in 1922. A steam-jet ash ejector and a dual-drive exciter were also included in the 1922 installation. The old plunger boiler-feed pumps were replaced by centrifugal turbine-driven pumps and the feed water controlled with automatic regulators. The equipment installed was built for 220-lb. pressure, it being intended that this should be the final operating pressure.

The difficulty presented under the second disadvantage was partly removed when it was found by check and test that enough piling had originally been driven to support the new equipment. In the generator room two 500-kw. units and their auxiliaries were removed to make room for the 5,000-kw. generator and its auxiliaries and a dual-drive exciter set of 200-kw. capacity, large enough to excite three 5,000-kw. units.

In the boiler room the washroom, workbench and firebrick storage place was cleaned out to provide room for two 5,500-sq.ft. boilers and two forced-draft fans for these boilers. Then the second difficulty presented itself, and the task of getting the slabs removed and the piling sawed off, where the ashpit for the boilers was to be made, almost proved a sticker. This pit had to be made tight to a depth of 12 ft., of which 8 ft. was under water, and the entire mass consisted of heavy pine and hemlock slabs.

It was figured that to drive steel sheetpiling to hardpan within the building would make the job prohibitive, so it was decided to remove the slabs from a space larger than required for the pit and sheetpile with planks to a depth of about 12 ft. Chisels were made with cutting blades four to eight inches wide, with vertical handles welded on so that a sledge hammer could be used for cutting the slabs down, leaving straight wall sides, the chisel handles being lengthened as the depth increased.

After all refuse and slabs were removed to the proper depth and the bottom of the space leveled and the sides sheetpiled, the bottom of the pit was concreted with a dry mix of 1-2-3 concrete over to a depth of 10 in. and left undisturbed for seven days, after which the pit was pumped dry and the job was almost perfect. The permanent floor was then poured on top of the sealing base and in one form with the side walls, making an excellent job.

In the generator room the fourth disadvantage presented itself and was entirely overcome by the use of dynamite. First all tie walls to the main building walls were cut loose from the main walls and operating machinery foundations by the use of air and steam hammers, so as to avoid carrying the jar of the explosion or shock to such walls or operating machinery.

Dynamite in small charges, no more than one-half stick at a time, removed all old concrete foundations rapidly and satisfactorily without the least disturbance to the building or operating machinery and without the slightest accident. For protection, every shot was covered with brush, and when firing, all doors and windows were opened to prevent damage by concussion.

In constructing the switchhouse and busbar room, the fifth disadvantage presented itself and was overcome by purchasing enough three-conductor lead-covered cables to handle the largest load. This was spliced into all circuits that could not be interrupted while under load. A liberal allowance of cable was used, so that it could be moved in such a manner as to allow the erection of the switchhouse addition and facilitate the moving about of the pile-driver, to drive the necessary piling. In connection with the driving of the piling, advantage was taken of the piling to supply the means of a good ground connection for grounding the equipment by boring a hole for a No. 2 solid wire about 2 ft. from the point of the pile. The wire was shoved through the hole, bent upward 2 ft. and pounded into the wood and stapled; the other end was stapled to the opposite side of the pile up to its head, with a few feet surplus of wire for connection. These ends were later grouped and serve as a remarkably good ground connection, as the piles penetrated to a depth of from 22 to 47 ft.

The sixth disadvantage was overcome by building the foundations for the turbine-generator sets, up to the condenser floor line, and the foundations for the condensers themselves, after which the condensers were moved into position and then the piers for the turbine-generators were completed. This made accurate work absolutely necessary, which was accomplished by making permanent bench marks on the steel columns of the building before the work was

ELECTRICAL DEPARTMENT

MONTHLY STATION REPORT FOR Month of January 1926

COMPANY L.S.D.P. Co. STATION Bay Front DISTRICT Ashland

PRODUCTION	THIS MONTH
RATED CAP. IN Kw. OF GEN. STEAM	15,000
RATED CAP. IN H.P. BOILERS	4,012
TOTAL GENERATION STEAM, GROSS	4,102,400
MAXIMUM HOUR GENERATION	8,500
MAXIMUM 15-MINUTE PEAK	9,600
POWER FACTOR THRU MAX. HOUR	87% &
VOLTAGE AT BUS	2,400
VOLTAGE AT BUS	
VOLTAGE AT BUS	
STATION LOAD FACTOR	84.8%
STATION OPER. CAP. FACTOR	68.4%
STATION SERVICEABILITY FACTOR	100%
AV. HEAT TRANSF. PER SQ. FT. HT. SURFACE	7835
STEAM PRESS. MAIN UNIT	197
SUPERHEAT, MAIN UNIT	153.5
ABS. EXH. PRESS. MAIN UNIT	8 in. Hg.
TOTAL WATER EVAPORATED M Lb.	68,260
STEAM CHGD. OTHER USES	none
MAKE UP WATER (TOTAL) 4.05% or	2,798,370#
PLANT EMP. (OPERATION)	4,672 hrs.
PLANT EMP. (MAINT.)	915 hrs.
SOURCE OF FUEL	W. Virginia
	Cedar Grove & Mammoth Mines
KIND OF FUEL	Splt. Scrgs.
COST OF FUEL IN BUNKERS per ton	$4.355
COST OF HANDLING FUEL " "	.045
COST OF REFUSE DISPOSAL " "	.128
FUEL IN STORAGE tons	398.71
FUEL FIRED M. lb.	7,809.3
TOTAL EQUIV. PRIM. FUEL	None
B. T. U. PER UNIT AS FIRED	10,586
BOILER EFFICIENCY	75%
STEAM PER KW. HR. OUTPUT	17.14
FUEL PER KW. HR. OUTPUT	1.96
B. T. U. PER KW. HR. OUTPUT	14,247.36
RATED CAP. OF GEN. HYDRO	
TOTAL GENERATION HYDRO	
MAXIMUM HOUR GENERATION	
MAXIMUM 15-MINUTE PEAK	
POWER FACTOR THRU MAX. HOUR	
VOLTAGE AT BUS	
VOLTAGE AT BUS	
VOLTAGE AT BUS	
VOLTAGE AT BUS	
STATION LOAD FACTOR	
STATION OPERATING CAP. FACTOR	
STATION SERVICEABILITY FACTOR	
AVAILABLE FLOW FOR POWER (MEAN)	
UTILIZED FLOW FOR POWER (MEAN)	
% AVAIL. FLOW UTILIZED	
GROSS HEAD (MAX.)	
GROSS HEAD (MIN.)	
GROSS HEAD (AVERAGE)	
PLANT EFFICIENCY	
POSSIBLE OUTPUT FROM FLOW	
PLANT EMPLOYEES	

ANALYSIS OF STATION OUTPUT AS GENERATED	THIS MONTH
K.W.H. 2300 VOLTS 3Ø CYCLES	
K.W.H. VOLTS D.C. A.C.	
K.W.H. VOLTS D.C. A.C.	
K.W.H. GENERATED—STEAM	4,102,400
K.W.H. GENERATED—GAS ENGINES	
K.W.H. GENERATED—OIL ENGINES	
K.W.H. GENERATED—TOTAL	4,102,400
K.W.H. USED IN STATION	117,600
K.W.H. NET OUTPUT OF STATION	3,984,800
DISTRIBUTION OF STATION OUTPUT	
K.W.H. 66,000 VOLTS TRANS. LINE	2,815,500
K.W.H. 33,000 VOLTS TRANS. LINE	791,000
K.W.H. 16,500 VOLTS TRANS. LINE	241,520
2,300 volt trans. lines	250,049
POUNDS STEAM PER LB. FUEL USED	8.741
B. T. U. PER LB. STEAM GENERATED	1415
HOURS OPERATED DURING MONTH	
STEAM UNIT NO. 1	175
STEAM UNIT NO. 2	280
STEAM UNIT NO. 3	704
STEAM UNIT NO. 4	
STEAM UNIT NO. 5	
GAS ENGINE NO. 1	
GAS ENGINE NO. 2	
OIL ENGINE NO. 1	
OIL ENGINE NO. 2	
MEMORANDUM OF COAL APPORTIONMENT ACCT	
ELEC. UTILITY PROPORTION OF COAL (TONS)	
GAS UTILITY PROPORTION OF COAL (TONS)	
WATER UTILITY PROPORTION OF COAL (TONS)	
HEAT UTILITY PROPORTION OF COAL (TONS)	
ICE UTILITY PROPORTION OF COAL (TONS)	
RAILWAY UTILITY PROPORTION OF COAL (TONS)	

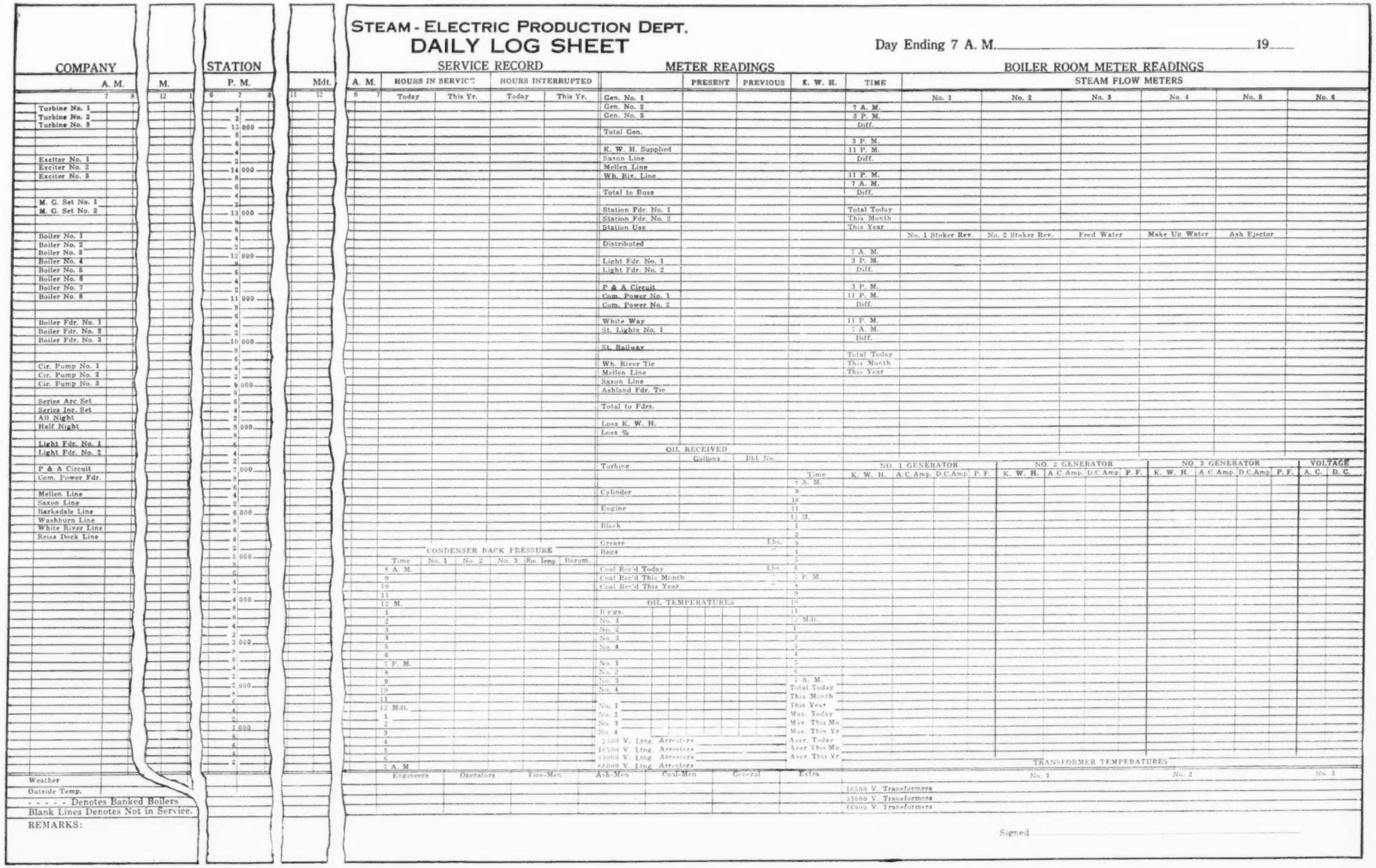
FUEL

STATE IN TONS AND GALLONS	COAL	OIL		COAL
ON HAND BEGINNING MO.				468.95
RECEIVED DURING MO.				3,847.9
TOTAL				4,316.85
USED DURING MO.	SOLD TO EMPLOYEES			3,904.65
BAL. ON HAND END OF MO.				398.71

COAL per K.W.H. (As Generated) 1.903 lbs.
COAL per K.W.H. (To Feeders) 1.96 lbs.

NOTE:- Figure as shown in heat transfer is not correct, insofar, as steam leaving our boilers is superheated to about 50 degrees.

Fig. 6—Monthly operating sheet



STEAM - ELECTRIC PRODUCTION DEPT.

DAILY LOG SHEET

Day Ending 7 A. M. _____ 19____

COMPANY | STATION | A. M. | M. | P. M. | Mdt.

Turbine No. 1
Turbine No. 2
Turbine No. 3

Exciter No. 1
Exciter No. 2
Exciter No. 3

M. G. Set No. 1
M. G. Set No. 2

Boiler No. 1
Boiler No. 2
Boiler No. 3
Boiler No. 4
Boiler No. 5
Boiler No. 6
Boiler No. 7
Boiler No. 8

Boiler Fdr. No. 1
Boiler Fdr. No. 2
Boiler Fdr. No. 3

Cir. Pump No. 1
Cir. Pump No. 2
Cir. Pump No. 3

Series Arc Set
Series Inc. Set
All Night
Half Night

Light Fdr. No. 1
Light Fdr. No. 2

P & A Circuit
Com. Power Fdr.

Mellen Line
Saxon Line
Barksdale Line
Washburn Line
White River Line
Reiss Dock Line

Weather
Outside Temp.
- - - - - Denotes Banked Boilers
Blank Lines Denotes Not in Service.
REMARKS:

SERVICE RECORD

A. M.	HOURS IN SERVICE		HOURS INTERRUPTED	
	Today	This Yr.	Today	This Yr.

METER READINGS

	PRESENT	PREVIOUS	K. W. H.
Gen. No. 1			
Gen. No. 2			
Gen. No. 3			
Total Gen.			
K. W. H. Supplied			
Saxon Line			
Mellen Line			
Wh. Riv. Line			
Total to Buss			
Station Fdr. No. 1			
Station Fdr. No. 2			
Station Use			
Distributed			
Light Fdr. No. 1			
Light Fdr. No. 2			
P & A Circuit			
Com. Power No. 1			
Com. Power No. 2			
White Way			
St. Lights No. 1			
St. Railway			
Wh. River Tie			
Mellen Line			
Saxon Line			
Ashland Fdr. Tie			
Total to Fdrs.			
Loss K. W. H.			
Loss %			

TIME	
7 A. M.	
3 P. M.	
Diff.	
3 P. M.	
11 P. M.	
Diff.	
11 P. M.	
7 A. M.	
Diff.	
Total Today	
This Month	
This Year	
7 A. M.	
3 P. M.	
Diff.	
3 P. M.	
11 P. M.	
Diff.	
11 P. M.	
7 A. M.	
Diff.	
Total Today	
This Month	
This Year	

BOILER ROOM METER READINGS

STEAM FLOW METERS

No. 1	No. 2	No. 3	No. 4	No. 5	No. 6

No. 1 Stoker Rev.	No. 2 Stoker Rev.	Feed Water	Make Up Water	Ash Ejector

OIL RECEIVED

	Gallons	Bbl. No.
Turbine		
Cylinder		
Engine		
Black		
Grease		Lbs.
Rags		
Coal Rec'd Today		Lbs.
Coal Rec'd This Month		"
Coal Rec'd This Year		"

CONDENSER BACK PRESSURE

Time	No. 1	No. 2	No. 3	Rm. Temp.	Barom.
8 A. M.					
9					
10					
11					
12 M.					
1					
2					
3					
4					
5					
6					
7 P. M.					
8					
9					
10					
11					
12 Mdt.					
1					
2					
3					
4					
5					
6					
7 A. M.					

OIL TEMPERATURES

Time	Burgs.	No. 1	No. 2	No. 3	No. 4
8 A. M.					
9					
10					
11					
12 M.					
1					
2					
3					
4					
5					
6					
7 P. M.					
8					
9					
10					
11					
12 Mdt.					
1					
2					
3					
4					
5					
6					
7 A. M.					

No. 1	
No. 2	
No. 3	
No. 4	
2300 V. Ltng. Arresters	
16500 V. Ltng. Arresters	
33000 V. Ltng. Arresters	
66000 V. Ltng. Arresters	

Time	NO. 1 GENERATOR K. W. H.	A. C. Amp.	D. C. Amp.	P. F.	NO. 2 GENERATOR K. W. H.	A. C. Amp.	D. C. Amp.	P. F.	NO. 3 GENERATOR K. W. H.	A. C. Amp.	D. C. Amp.	P. F.	VOLTAGE A. C.	D. C.
7 A. M.														
8														
9														
10														
11														
12 M.														
1														
2														
3														
4														
5														
6														
7 P. M.														
8														
9														
10														
11														
12 Mdt.														
1														
2														
3														
4														
5														
6														
7 A. M.														
Total Today														
This Month														
This Year														
Max. Today														
Max. This Mo.														
Max. This Yr.														
Aver. Today														
Aver. This Mo.														
Aver. This Yr.														

TRANSFORMER TEMPERATURES

	No. 1	No. 2	No. 3
16500 V. Transformers			
33000 V. Transformers			
66000 V. Transformers			

Engineers	Operators	Fire-Men	Ash-Men	Coal-Men	General	Extra

Signed _____

Fig. 7—Daily log sheet used in the Bay Front steam plant of the Lake Superior District Power Company

begun. The elevations were stamped into the steel at the marks. This worked so satisfactorily that at the time of erection of the machinery and piping not the slightest variation was found and the fits could have been no better.

The seventh disadvantage was overcome by careful planning of the rotation of handling the work and by taking daredevil chances several times, which in each case worked, and caused no interruptions to service.

The eighth disadvantage has not been overcome and will probably remain until a new plant is necessary.

This left us in 1924 with 10,000-kw. generating capacity; a poor heat balance on account of too much steam from auxiliaries; low-pressure, low-temperature steam; and not much of a check on operating conditions, as no provision had been made to allow for instruments, etc., for checking operating results. However, this installation reduced the coal consumption from 2.7 lb. to 2.48 lb. per kw.-hr., mostly due to the economy effected by the type of boiler installed.

Removing the Reinforced Concrete Stack

In 1924 the load again caught up to the installed capacity and plans to complete the plant to its ultimate size of 15,000 kw. were started. Here is where the third disadvantage, the removal of the reinforced-concrete stack 156 ft. high and 8 ft. diameter at the top, presented itself. A scaffold was built up inside of the stack, a movable guarded platform was built on the outside of and supported from the top of the stack. This platform was built to catch the broken concrete as the stack was demolished and protected the roof of the building and the men working below.

The stack was broken down by sledge hammer, with surprising results to within about 57 ft. from the floor level, where the steel became so plentiful that the sledge had not much effect. The guard was reinforced with sacks of hay and excelsior, then dynamite, in small charges, completed the demolition without damage or accident, except the loss of 11 window lights. The contractor used most of the scaffolding lumber again in erecting the new stack.

The four 3,500-sq.ft. boilers, originally installed, were removed with the stack that served them, and two 8,860-sq.ft. boilers were installed, one in the space occupied by two old boilers. Two motor-driven forced-draft fans were set where the stack formerly stood. The last of the original 500-kw. vertical turbine-generator units was removed and a 5,000-kw. machine installed in its place. The removal of the foundations under the four boilers, the stack and the last 500-kw. unit, was again accomplished by dynamite, the blasts being protected with brush.

Metering Devices Installed

With the last installation we put in steam-flow meters of the indicating, recording and integrating type, combustion recorders, draft gages at each point where draft is controlled, feed-water meters and meters on the steam lines to the ash ejectors. Damper regulators were also installed on the fans, and the main dampers were put on hand control within easy reach of the fireman. Recording thermometers were provided to record the temperature of the feed water, the steam entering the superheaters, the steam at the turbine throttles and the temperature of the condensing water at the inlet and outlet.

A hotwell was installed to catch the overflow from the feedwater heaters at times of fluctuating load. All raw makeup water is first discharged into the hotwell, except when the hotwell is practically empty, and is from there delivered by a pump into the heater. By doing this no condensate or pure water is wasted. It is possible, without the use of any compound or device other than the heater, to keep the boilers in clean condition by running a turbine cleaner through the tubes in May and October. This is done more as a matter of surety against tubes becoming blocked than for actual cleaning reasons, as this is the only time the boilers are opened.

Good Results Obtained

Some of the features that contribute to the good results obtained, after the completion of the 1925 installation, were a change from turbo- to steam-jet air pumps; the increase in pressure from 155 to 220 lb.; the increase in steam temperature both by pressure and by raising the superheat at the throttle from 50 to 150 deg. F.; the good condensing-water condition, assisted by special intakes installed during and since 1925; the complete records which we have from the instruments installed and which are kept well maintained; the hotwell, whereby no waste of pure water from drips or heater overflow is allowed; the good control of fires by the stokers; and last, but not least, excellent boilers which furnish steam superheated from 17 to 50 deg. at the entrance into the superheaters and which have operated continuously for two months at an average of 288 per cent of rating and at 74 per cent efficiency.

These figures were not obtained after a preparation for test, but are for a regular run of two months and without internal cleaning of the boilers for four months prior to the run.

To date no furnace brickwork maintenance has been necessary and the coal consumption has been reduced from 2.48 lb. to, on the average, less than 1.9 lb. per kw.-hr., as generated, or about 1.95 lb. net to the outgoing feeders.

A sample of monthly operating sheets and the daily log sheet are shown in Figs. 6 and 7.

Interesting Features

Some of the interesting features of the plant are:

1. The complete operating records maintained.

2. The general cleanliness in spite of the crowded condition of the plant.

3. The entire operation and maintenance of equipment, premises and buildings is taken care of by 18 men, nine of whom are on 8- and nine on 9-hour shifts.

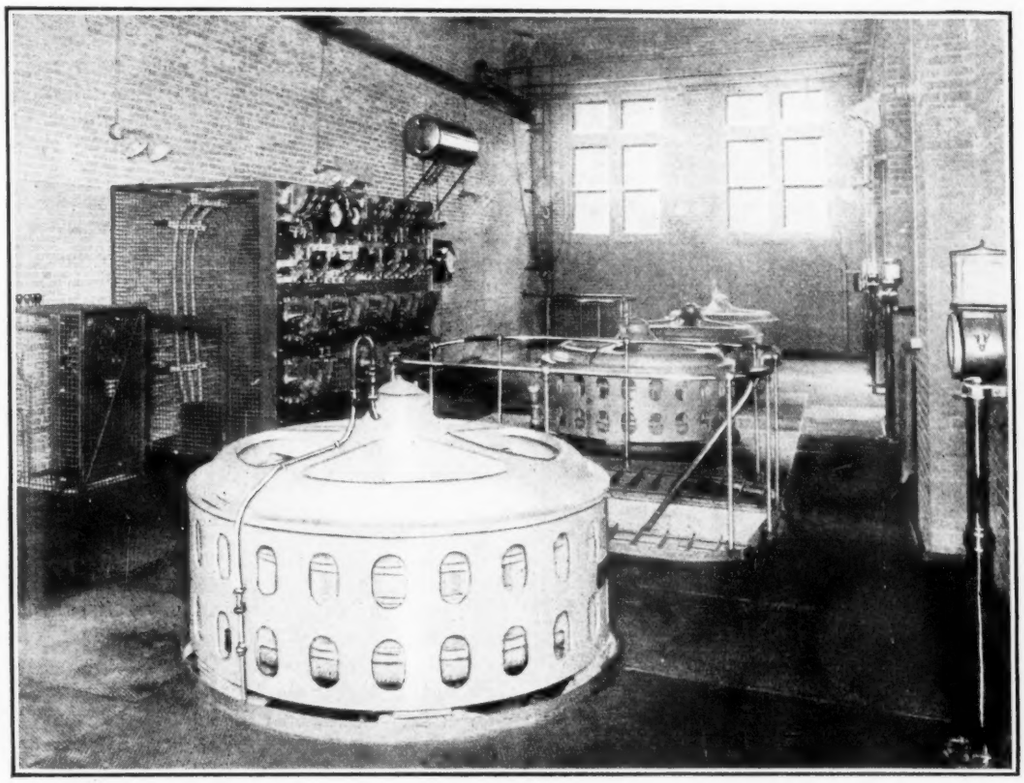
4. The painting of all pipe lines is of one color, a pleasing dark gray, with arrows in white, stenciled thereon, showing the direction of flow, and in a white circle on the shaft of the arrow are stenciled in black the contents in the pipe and the pressure carried.

5. Nine, out of the eighteen men employed, have completed a course of training in the Bureau of Mines First Aid Instruction and a first-class first aid team is maintained and time loss accidents have practically been eliminated.

6. The complete installation of fire-fighting equipment, properly maintained and inspected twice each month.

7. Every coupling or flywheel in this station is protected by a steel guard, painted a bright red.

ELECTRICAL *Operation and Maintenance*



Factors That Should Be Considered When

Selecting Conductors for Power Circuits

By J. Elmer Housley

OF OUTSTANDING importance is the National Electric Code both in the selection of conductors for power circuits and their installation. While without statutory power this code is the recommendations followed by the National Board of Fire Underwriters and is recognized by practically all regulating bodies in the United States. A copy of the code should be studied before any electrical layouts are undertaken. The code includes the allowable or safe current-carrying capacities of wires with various insulations and the minimum sizes of conduits for various sizes of wire, as shown in the table.

Knowing the details of the motor or power groups to be wired up, such as the line voltage and the probable full-load current, the insulation of the wire should first be selected even before the wire size is calculated. This may appear strange to many, but several factors, the most important of which is the type of insulation, enter into the calculation of a conductor size. A list of the types of bare and insulated conductors in more general use in moderate sized industrial or power plants follows:

1. Bare ground wire, cable or busbar.
2. Bare cable or busbar mounted on insulators.
3. Insulated wire or cable, code rubber, braided cover.
4. Insulated wire, intermediate rubber, braided cover.
5. Insulated wire, 30 per cent Para, braided cover.

6. Insulated wire, varnished cambric, braided cover. A lead cover may be added to above, omitting the braid and using one tape wrapping.
7. Insulated cable, impregnated paper, lead covered.
8. Insulated wire or cable, triple weatherproof braid.
9. Insulated wire or cable, slow burning.

Bare wire as in item No. 1 is found on transformer and generator neutrals, ground wires and traction generator negative bus. Bare cables or busbar mounted on insulators is used for power house or substation busbars, where the conductors are housed or guarded and not accessible to other than authorized attendants. The classes of wire referred to in items 3, 4 and 5, are used for indoor open and inclosed wiring. The generally used material is the double braid rubber-covered, National Electric Code standard. Unusual plant conditions or the importance of the installation may dictate the use of a better material, combining a longer life and a higher dielectric strength or better insulating qualities. The highest-quality material is used for important control wiring or where severe conditions exist, yet short of a condition requiring lead-covered cable.

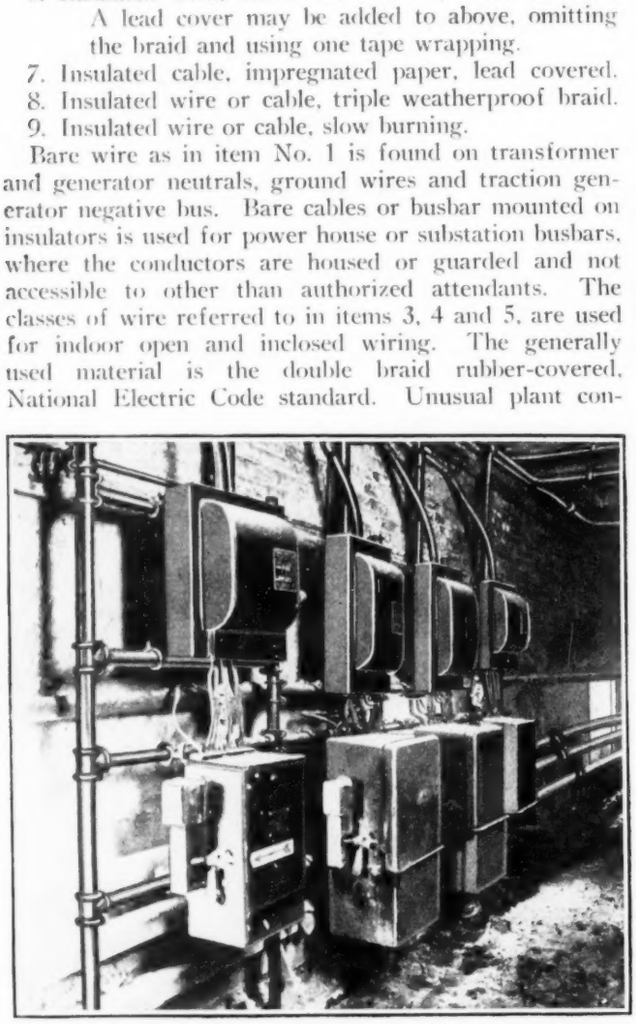


Fig. 1—Grouping of starting and protective equipment

Items Nos. 6 and 7, varnished cambric cables, are used for high-voltage service, 600 to 15,000, with either a braided or a lead covering. This cable is fairly flexible and may be operated at higher temperatures than is possible with rubber. It is used largely for inside station wiring for generator leads, etc. Paper-insulated cable is impregnated with insulating oils, and a lead covering is essential and potheads must be provided at each end of the cable to prevent loss of the impregnating oil or the entrance of moisture. Paper insulation is cheaper than varnished cambric and is extensively employed for high-voltage feeder circuits in duct or conduit lines.

Weatherproof triple braid wires, item No. 8, must be used for outdoor exposed wiring exclusively. Slow-burning braided conductors, item No. 9, may be used for open interior wiring in hot locations. They are frequently used for resistor wiring. The insulating value of both No. 8 and No. 9 types of covering is low.

In every installation a study should be made of the possibility of overvoltages existing on the wires at some future time. The overvoltage may arise from rejection of load and consequent overspeeding of generators, line surges, static or lightning discharge which may be picked up by any line running through the plant yard. A high-grade installation may be protected by increasing the insulation of the wires and by suitable lightning-arrester protection or by the use of transformer banks at the building entrance of power feeders.

The maximum temperature allowable for paper-insulated cables is 85 deg. C. and for varnished cambric insulation 75 deg. and for rubber insulation 60 deg. The puncture resistance is lowered somewhat at the higher temperatures, and the voltage rating is therefore sometimes lowered where high temperatures are expected.

In the moderate-sized plant the distribution system is nearly always installed for the nominal motor voltage, the substation or generator voltage should be 460 volts for operating 440-volt motors, allowing about 5 per cent voltage drop in the feeder and motor circuits under worse conditions. Low voltage greatly increases the line losses on account of the increased current taken by the motors. It is preferable to operate a motor at 5 per cent overvoltage rather than 5 per cent undervoltage. The size of feeders will depend somewhat on the grouping of the motors and the kind of pole line desired, if the latter has to be used. Again, cables larger than 500,000 or 1,000,000 circ.mils aluminum are rather difficult to install on pole or tower lines without special equipment to prevent damage to crossarms.

A cable of 500,000-circ.mil copper or the equivalent aluminum size of 795,000 circ.mils will, under average conditions, carry about 600 amperes open wiring. This is also the largest capacity single body fuse permitted by the underwriters, and the use of a heavier feeder or if the necessary protection is obtained, it will call for an oil switch or air circuit breaker. After the feeder reaches a building or load center, a distribution center should be installed. From this point the number and size of feeders to the various groups of motors will be determined by the convenient arrangement of feeders and the load that will be expected on the feeder. A safety-type fused switch may be installed for each group feeder, combining a disconnecting switch and overload or overcurrent protection.

Open Versus Conduit Wiring

The question of open wiring versus conduit wiring has been discussed for years, but conduit wiring is used almost exclusively in modern high-grade installations. Open wiring is unsightly, is a source of danger and is exposed to all sorts of hazards. The exposed insulation deteriorates rapidly when exposed to chemical fumes, dirt and moisture. Conduit permits the insulation to perform its function without being subject to attacks which it was not intended to combat. Conduit makes a good appearance, occupies little space as compared with open wiring, and may be run in locations exposed to plant hazards. Only in rare occasions is open wiring required because of excessive heat; in such case the open wiring mains may be run near the roof or ceiling and conduit branch feeders may be run vertically to connect between the mains and motor groups. Conduit runs become quite expensive for sizes of 3-in. or larger. For reasons mentioned previously, distribution feeders should be limited to 500,000-circ.mil. cables.

From the viewpoint of economy, voltage regulation, code requirements and ease of operation the motor control and protective equipment should be grouped for as many motors as possible. Such a grouping is shown in Fig. 1. Advantage of the diversity of load on the group is taken in the feeder, and voltage fluctuations are minimized. A large number of small branch circuits are eliminated, and the cost of wire per motor is reduced.

For determining the motor and feeder cable sizes, the full-load current rating on the nameplate will serve as a

CURRENT-CARRYING CAPACITIES OF CONDUCTORS AND CONDUIT SIZES

B. & S. Gage No.	Area in Circular Mils = (Dia. in Mils)²	Current-Carrying Capacities of Conductors			Required Size of Conduit, Two-Wire and Three-Wire Systems No. of Conductors in One Conduit								
		Rubber Covered	Varnished Cloth	Other Insulations	1	2	3	4	5	6	7	8	9
					Minimum Size of Conduit, Elec. Trade, Size, In.								
....	2,000,000	1,050	1,260	1,670	3	5	6	..	..	..	..	..	..
....	1,900,000	1,010	1,210	1,610	3	5	6	..	..	..	..	..	..
....	1800,000	970	1,160	1,550	3	5	6	6	..	..	..	..	..
....	1,700,000	930	1,120	1,490	3	5	5	6	..	..	..	..	..
....	1,600,000	890	1,070	1,430	2½	5	5	6	..	..	..	..	..
....	1,500,000	850	1,020	1,360	2½	4½	5	6	..	..	..	..	..
....	1,400,000	810	970	1,290	2½	4½	5	6	..	..	..	..	..
....	1,300,000	770	920	1,220	2½	4½	5	6	6	..	..	..	..
....	1,200,000	730	880	1,150	2½	4½	4½	6	6	..	..	..	..
....	1,100,000	690	830	1,080	2½	4	4½	6	6	..	..	..	..
....	1,000,000	650	780	1,000	2	4	4	5	6	6	..	..	..
....	950,000	625	750	960	2	4	4	5	6	6	6	..	..
....	900,000	600	720	920	2	3½	4	4½	5	6	6	..	..
....	850,000	575	690	880	2	3½	4	4½	5	6	6	..	..
....	800,000	550	660	840	2	3½	4	4½	5	6	6	6	..
....	750,000	525	630	800	2	3½	3½	4½	5	6	6	6	..
....	700,000	500	600	760	2	3¼	3½	4½	5	5	6	6	..
....	650,000	475	570	720	2	3½	3½	4	4½	5	6	6	6
....	600,000	450	540	680	2	3	3½	4	4½	5	6	6	6
....	550,000	425	510	640	1½	3	3½	4	4½	5	5	6	6
....	500,000	400	480	600	1½	3	3	3½	4	4½	5	5	6
....	450,000	365	435	550	1½	3	3	3½	4	4½	4½	5	6
....	400,000	325	390	500	1¼	3	3	3½	4	4	4½	5	5
....	350,000	300	360	450	1¼	2½	3	3½	3½	4	4½	4½	5
....	300,000	275	330	400	1¼	2½	3	3	3½	3½	4	4½	4½
....	250,000	250	300	350	1¼	2½	2½	3	3	3½	3½	4	4½
0000	211,600	225	270	325	1¼	2	2½	2½	3	3	3½	3½	4
000	167,800	175	210	275	1	2	2	2½	3	3	3	3½	3½
00	133,100	150	180	225	1	2	2	2½	2½	3	3	3	3½
0	105,500	125	150	200	1	1¼	2	2	2½	2½	3	3	3
1	83,690	100	120	150	¾	1½	1½	2	2	2½	2½	3	3
2	66,370	90	110	125	¾	1¼	1½	1½	2	2	2½	2½	2½
3	52,630	80	95	100	¾	1¼	1¼	1½	2	2	2	2½	2½
4	41,740	70	85	90	¾	1¼	1¼	1½	2	2	2	2	2½
5	33,100	55	65	80	¾	1¼	1¼	1¼	1½	2	2	2	2
6	26,250	50	60	70	¾	1	1¼	1¼	1½	1½	2	2	2
8	16,510	35	40	50	¾	¾	1	1	1	1¼	1¼	1¼	1¼
10	10,380	25	30	30	¾	¾	¾	1	1	1	1¼	1¼	1¼
12	6,530	20	25	25	¾	¾	¾	¾	¾	1	1	1	1¼
14	4,107	15	18	20	¾	¾	¾	¾	¾	1	1	1	1
16	2,583	6	....	10	..	..	..	..	..	..	..	..	..
18	1,624	3	....	5	..	..	..	..	..	..	..	..	..

base. Due consideration of the possibility of the motor size being increased will sometimes prevent a costly job of alteration. The code requires that the conductor carrying capacity for single motors be not less than 110 per cent of nameplate current rating. For squirrel-cage motors the high starting current, which is 250 per cent of nameplate rating with reduced voltage starters either compensators or resistance type, requires a conductor between compensator and feeder for 250 per cent full-load current on motors rated 30 amperes or less and 200 per cent for 30 amperes and above.

Running fuses of not over 125 per cent motor current rating are advised by the code. The complication of starting fuses may be avoided by the use of a compensator-type fused safety switch. Contacts for the starting leads are made ahead of the running fuses. In such a case the feeder should be fused for not over 500 per cent of the motor conductor rating. The branch circuit from the feeder to motor control need not be fused at the junction box if the branch conductor is one-third (or larger) the size of the feeder and is not over 25 ft. in length.

What Do You Know?

By L. H. Morrison

The answers are on page 642

WHILE it is worth while to realize the extent of one's engineering knowledge, the real factor in getting ahead is to know more or as much as the other men in the plant or office. Jimmie Watts would present a sorry figure today, yet in his time he knew more of the properties of steam than anyone else—even though what he thought he knew was wrong.

If he were to be asked to answer these ten questions his batting record would fall far below that of the average engineer. But could you better our friend's record? Check your answers by those of the editor.

Ques. 1—Will one obtain the same horsepower from a uniflow and a Corliss engine of the same cylinder dimensions operating under the same conditions of initial pressure, exhaust and speed and with the same apparent per cent cutoff?

Ques. 2—Is the rise in temperature resulting from compression of a multi-atomic gas greater or less than of di-atomic gas like air?

Ques. 3—What is meant by the full-load slip of an induction motor?

Ques. 4—If the lower connection to the gage glass of a boiler is choked up with scale, will the indicated water level be correct? Why?

Ques. 5—Why should not one permit a centrifugal pump to be run empty?

Ques. 6—Suppose you had liquid ammonia in a tank at 80 deg. F., resulting in a vapor pressure of 138.3 lb. gage. Assume air at 80 deg. F. was pumped in so that the tank pressure gage registered a total of 203 lb. Now if the tank were submerged in brine and the temperature of the contents brought to 35 deg. F., which corresponds to a vapor pressure of 51.6 lb. gage, what would be the approximate pressure registered by the gage?

Ques. 7—What type of reciprocating engine has the best steam consumption record?

Ques. 8—What is the quickest way of removing rim links on a large flywheel?

Ques. 9—What is meant by the critical of a crankshaft?

Ques. 10—Why are the grates of the ordinary fire-tube boiler set so they incline downward toward the rear?

EDITORIALS

F. R. LOW, *Editor*

The Power Prize Contest

IN THIS issue announcement is made of the winners in the *Power* Prize Contest.

Among the forty-four papers submitted were a number possessing exceptional merit, and it was no small task for the judges to arrive at a decision. The painstaking manner in which the judges analyzed each paper, from the viewpoints of results achieved, ingenuity displayed, application to other cases, and method of presentation, deserves appreciation and insures confidence in their findings.

Besides the three winners, ten papers received special commendation. These and several others will be published as space permits.

In the aggregate the papers cover a wide range of conditions and contain a wealth of information that should inspire and assist other *Power* readers who may be confronted with the problem of power-plant betterment.

Power extends congratulations to the winners, its thanks to the judges and its appreciation to all who entered the contest.

Financing of Fundamental Research

LOUIS PASTEUR, that acknowledged master in the field of chemistry, once said, "Science is the soul of prosperity of nations and the living source of all progress." Although this statement was made about sixty years ago, it is only now that the people, even of the highly developed countries, are awakening to the full significance of the truth in Pasteur's remarks. Pure scientific research has too frequently been looked upon as something apart from industry. Research, if there was to be any, must be of a character that offered a fair assurance of immediate gain, according to the demand of the average industrial executive.

Experience in our industrial development has gone far enough to show the futility of such an attitude. Looking back over the industrial progress for the last fifty years, it will be found that the companies that have made the greatest progress are those that have devoted the most attention to research. New industries have been created from the results of research that, when started, promised little of a practical nature. However, when the work was completed, new avenues of industrial development were made possible not even dreamed of before.

Much of such research work is expensive and can be carried out only by some organization or group of companies large enough to absorb such expenditures without financial embarassment. What has been done by the tanning industry, in creating a permanent endowment of one million dollars for research in that industry, merits careful consideration by other industrial groups. This fund will insure the continuous and effective operation of the independent foundation incorporated for tanning research and will place this work beyond the vicissitudes of trade association and other interests.

This work is to be carried on at the University of Cincinnati. The agreement under which it will be conducted, provides that no research work not of a strictly fundamental character shall be undertaken. The Tanners Council of America will furnish the funds, and the results of all research will be published in reputable scientific journals. Here is apparently an organization set up within an industry to work for the whole industry, an organization which has no other obligations to that industry than to study fundamental problems and make public the results of its efforts. As this action is the outcome to several years' experience in endowed research, the new organization is by no means an experiment.

Process Industries at the Central Station

STATION economy is largely affected by load factor, and any influence that will increase the load factor tends to lower the cost of the power output. The editor of *The Engineer*, of London, remarks that this may be accomplished by the establishment near the central station of some electrothermal or electrochemical or refrigerating process industry with the object of consuming large quantities of energy without involving heavy capital expenditures or transmission equipment and losses. If the process can be selected so that it will not require highly technical supervision, so much the better. If the process is such that its power demand can readily be varied at will to supplement the remaining station load, ideal power generating conditions can be maintained. If the process does not admit arbitrary load variations, its demand curve must be studied with care, for the addition

of a low load-factor load may improve the load factor of a system. In any event, the addition of a steady twenty-four hour load will improve the load factor of a plant.

It appears that the Langerbrugge station, in Belgium, which uses the highest steam pressure in Europe and the highest steam temperature in the world, has taken a step in the suggested direction. The manufacture of calcium carbide has been chosen as most suitable to the local requirements, and a 3,500-kw. furnace has been in operation for nearly a year, with a capacity of some 20 tons of carbide per day. This has not only improved the load factor of the station, but has also developed a profitable and economically sound business.

Of course, high load factor means low cost through the reduction in fixed charges and in fuel and labor cost per unit of output through the operation of machinery closer to its most efficient running point for a larger number of hours per year. This may, for example, be a decrease of one or two mills per kilowatt-hour.

How shall this reduced cost be allocated? If all the rates are reduced by this amount, including the rate charged this new added stabilizing load, the rate for this new load will probably be too high to make it possible to operate the new industry in competition on the open market. Accordingly, the whole plan must be dropped, and present customers are thereby denied the advantage of a reduction in rate that, small in terms of units, bulks large in the aggregate.

If the entire saving be credited to the newly added load, that is, if this new increment of load be charged only with the resulting increment of plant cost—usually little more than the fuel cost—it will prove economically possible to sell this new energy at amazingly low rates that would be exceptionally attractive to industries requiring large measures of electric energy. But this would give other customers no benefit of the improvement effected through the more favorable load characteristics.

Somewhere between these extremes is a rational position that will benefit everybody equitably. The central station will have a better load factor and will produce power cheaper and sell more of it. The old customers will benefit from rates a little bit lower, not much for the small user, but mounting up to millions per year for all the old customers, the whole group of old customers. The new customer, operating an appropriate establishment near the power plant, will have the advantage of a profitable process that would otherwise not be economically possible in that territory. Whether the industrial establishment be a subsidiary organization ot the central station, or an entirely independent establishment, is aside the point.

The difficulty seems to lie in the setting of rates. State commissions do not look with favor upon preferential rates for seemingly similar service. This attitude is designed to check obvious abuses and is sensible practice, but sensible practice can be sound practice only when it is based upon or coupled with thoroughly sound economic theory. If the granting of preferential rates under strictly limited circumstances will result in benefits to the whole body of customers and to the entire community through broadening its productivity, why should it be proscribed? Interfering with intelligent applications of advancements in the realm of physical and chemical science in the light of well-considered economic principles may be killing the goose that lays the golden eggs, albeit under the guise of protecting the people from the vulture.

A Challenge to the States

AFTER the Federal Water Power Act became a law in 1920, it appeared for a time that the way had been cleared for rapid development of the country's water power. There has been unprecedented progress made in utilizing water power since this act was passed but there have developed serious conflicts between state and federal authority. These have become so critical in some cases as to threaten further development for years to come. Although these clashes have developed under the guise of protecting the public interest, they have frequently had the appearance of being basically for the expediency of some political agency and to satisfy the whim of a superior authority.

O. C. Merrill, Executive Secretary of the Federal Power Commission, in a recent address before the Southern Appalachian Power Conference, practically challenged the states to put their houses in order by enacting suitable laws that would adequately protect the public's interests in their water-power resources. It is urged that the states enact laws which will enable them to take a far greater part than any of them are now taking in the control and regulation of water-power development and use.

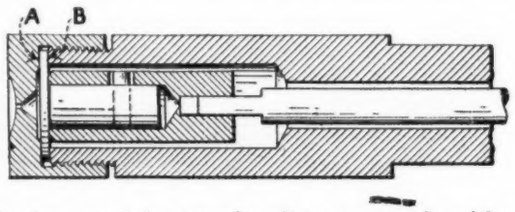
The regulation of rates, service and securities; responsibility for inspection, for construction and for auditing accounts; determination of the projects to be developed and the agencies by which they should be made —these are matters that it is preferred that the states should take over and in which the Federal Power Commission offers its fullest co-operation in working out a mutual program of power development in the public interest. Notwithstanding all that has been said in most state legislative bodies about the protection of public interests in water-power resources, few of them are in a position to take over the work suggested by Mr. Merrill. Is it not about time that legislators quit haggling over their prerogatives and accept this challenge of the secretary of the Federal Power Commission to do something constructive?

IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Leak in Oil Burner Causes Sparks to Issue from Flame Cone

IN ATTEMPTING to cut down fuel consumption in a plant using oil burners of the mechanical atomizing type, it was noticed that sparks were issuing from the flame cone and around the outside of the flame. We knew this to be a sign of improper atomization, but repeated cleaning of burners and strainers failed to remedy the trouble.



Leakage on joint permits oil to pass to tip without going through atomizer

It was finally decided that oil was passing through the orifice of the burner, which had not come through the tangential slots in the atomizer. This oil was caught up by the whirling stream from the atomizer and carried through the orifice. These stray particles being larger and heavier, were thrown to the outer edge of the flame, causing the spark-like effect.

The joint between the atomizer and the tip, as at *A* and *B* in the illustration, was ground with fine grinding compound, making the joint oiltight. After this the atomization was perfect and the saving in fuel was noticeable.

The parts of the burner are often scarred or scratched in cleaning, and frequent inspections should be made to make sure that the orifice is perfectly round and the joint between the atomizer and the tip is oil tight.

Brooklyn, N. Y. P. F. CALLAGHAN, JR.

Stopping Engine Noise

A HIGH-SPEED shaft governed engine in a hotel was always noisy when the peak load came on and thorough inspection of all bearings and governor parts failed to disclose the cause of the trouble. As a result, a smaller unit had to be used to carry part of the load, which resulted in a large waste of steam. The chief told me that the trouble was due to the steam pressure being too low for the peak load and that he believed the governor was hitting the stops. As he could not raise the pressure, he contemplated having the small unit rebored and new valves fitted.

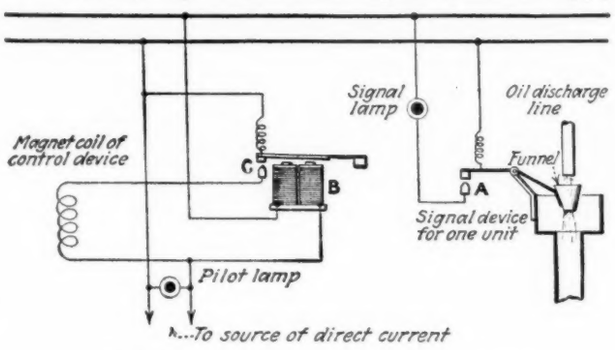
The nameplate on the generator gave the speed as 250 r.p.m. I then noted his engine speed with a watch, and it proved to be 238 r.p.m., or about 5 per cent low. After midnight we shut down and the governor spring was tightened till the engine ran at the rated speed. The next night the pound did not appear as soon as usual and then only for a few minutes when a certain machine was being used. To stop the noises entirely, we had to tighten the governor spring till the speed was 5 per cent high and the increased speed reduced the cutoff to a point where the governor kept off the stop.

The chief was so pleased with the improvement in the engine that he asked me to see what could be done to make the dashpots on his Corliss-driven ice machine operate quietly. I took a 20-gal. grease container and placing it below the floor, connected the air discharge from the dashpot cylinders into it with $\frac{1}{8}$ in. pipe and gave him another surprise. The dashpots could hardly be heard anywhere in the engine room, but the noise was not really eliminated, it was simply transferred to a place where there was no one to hear it. H. H. GORDON.

Thompsonville, Conn.

An Oil Alarm System for Small Steam Turbines

MOST engineers who operate steam turbines appreciate the seriousness of a sudden stoppage of the oil supply to the bearing while the machine is in regular operation. It has always been my contention that some reliable method by which an interruption in the oil supply might be detected before damage was done would be well worth while. Finally, I decided to try it, and the illustration shows how it was done.



Wiring diagram of oil stoppage signal

The sketch is self-explanatory, but a few remarks about its operation might be helpful. The oil overflow is taken from a point above the highest part to be

lubricated. The oil flows from the overflow into a funnel so constructed that with the normal flow of oil the funnel will be held in its lowest position and the contact *A* open.

Should the supply fall below normal, the contact *A* will close, causing the signal lamp to light up and the relay *B* to close the contact *C*, which in turn energizes the magnet coil of the control device, which can be made to bring an auxiliary oil pump into service, close the throttle valve of the turbine, or perform any other emergency operation desired. As soon as the alarm is sounded, the signal lamp indicates which machine is in trouble and the pilot lamp indicates to the operator whether or not the magnet coil of the control device has become energized.

I might mention that this signal device was put into use several years ago and has not as yet failed to function when the oil flow has dropped below normal.

Bluestone, W. Va. M. T. PERRY.

Pointers on Evaporator Practice

IN VIEW of the increasing use of evaporators there are a few points that I thought might be worth while bringing to the attention of *Power's* readers. First, the evaporator must deliver pure vapor to the condenser or the heater if that is used as the condensing medium. To do this priming must be eliminated, and it can be by a little care. Secondly, the evaporator must be supplied with steam from the most economical source and the resulting vapor must be used so its heat content, which is roughly equal to that of the steam supplied, is saved. I operated evaporators several years at sea, and I have seen two different ways of supplying steam and using the vapor, neither of which is highly economical.

The first one is wasteful, as high-pressure steam is admitted to the evaporator coils and the vapor sent directly to the condenser at 26 in. of vacuum. The only advantage of this method is the use of small units, as the heat transfer is high with a steam temperature of 360 deg. or above, in the coil and less than 140 deg. water in the evaporator, the evaporator feed water being taken from the condenser discharge at 120 deg. But the high rating results in excessive priming, which is serious with salt-water feed and in one ship I overcame it as follows:

The discharge from the evaporator to the condenser was diverted into the low-pressure receiver of our triple-expansion engine at 8 lb. pressure, which rose to 10 lb. owing to the increased steam supply. This eliminated the priming because it reduced the rating at which the evaporator could be worked, the heat transfer being reduced in proportion to the increase in vapor temperature, which rose from 140 to 240 deg. This, of course, reduced the capacity, but as the evaporators were in duplicate, the desired capacity was secured by running both units. As the indicated power of the low-pressure cylinder increased 10 per cent, the economy of this plan is evident.

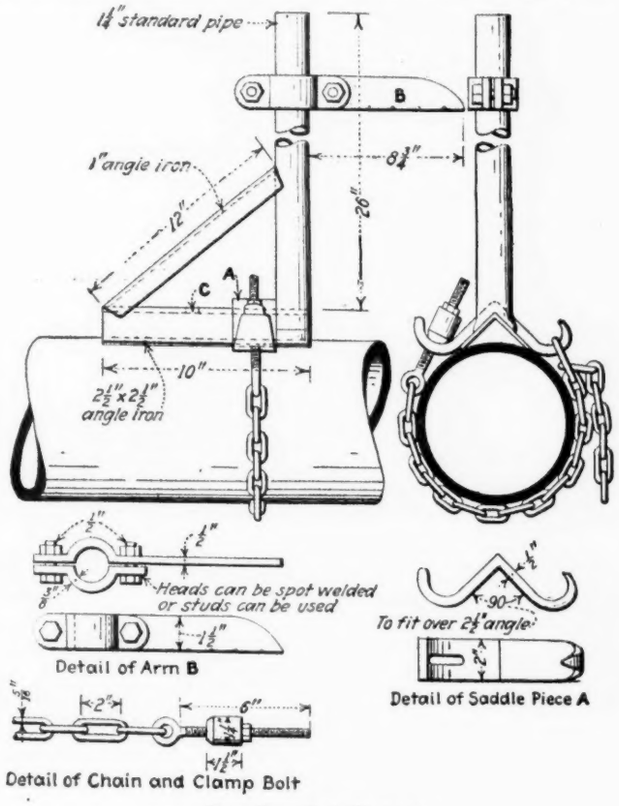
The other method in common use on ships having no steam-driven auxiliaries is to send the vapor into a line connecting with the low-pressure receiver and also with the feed heater. This can also be improved upon, as a chief engineer under whom I served, demonstrated. The feed pumps, air and circulating pumps and bilge pumps were all driven from the main engine, so comparatively little exhaust was available for feed heating. He had only one evaporator and ran it constantly, the vapor going to the heater, any excess or deficiency being taken care of by a 2-in. connection to the low-pressure receiver, 5 lb. pressure giving 224-deg. feed water. He ordered a unit twice the size of the old evaporator, and after installation he connected it so the vapor went to the heater as formerly, but placed a 2-in. equalizing pipe on the intermediate engine receiver, which allowed 39 lb. pressure to be carried on the heater and evaporator shell. The old 2-in. line to the low-pressure receiver was run into the hotwell, which had a tight cover, thus permitting the temperature to be raised to 200 deg. The increased vapor pressure in the heater raised the final temperature to 280 deg., and a test made with the heater condensate showed purer water than formerly. G. H. HART.

Thompsonville, Conn.

Drill Post for Use on Round or Flat Surfaces

The sketch shows a drill post that I have designed for drilling holes in pipes and cylinders or in flat surfaces.

It can be quickly clamped to any size pipe from 4-in. up to several feet in diameter. It consists of a piece of



Details of drill post

1¼-in. standard iron pipe welded to the end of a piece of 2½x2½x¼-in. angle iron and braced with a piece of 1x1-in. angle. The saddle *A* is welded to the back of the 2½-in. angle.

A 11/16-in. hole is drilled through the angle at *C* to permit bolting the drill post to a flat surface. The complete drill post weighs about 18 lb., so can be readily packed around. E. J. JORDAN.

Long Beach, Calif.

COMMENTS *from* READERS

How the Boiler Feed by Means of Traps Was Made Automatic

IT IS noted in the perusal of the Aug. 23 issue of *Power* that on page 300 C. W. Stevens describes a means for automatically operating a boiler feed and emphasizes its apparent novelty.

However, for many years we have made use of and recommend the method as disclosed in connection with our steam traps, and which we have protected by letters patent No. 1,251,092, dated Dec. 25, 1917.

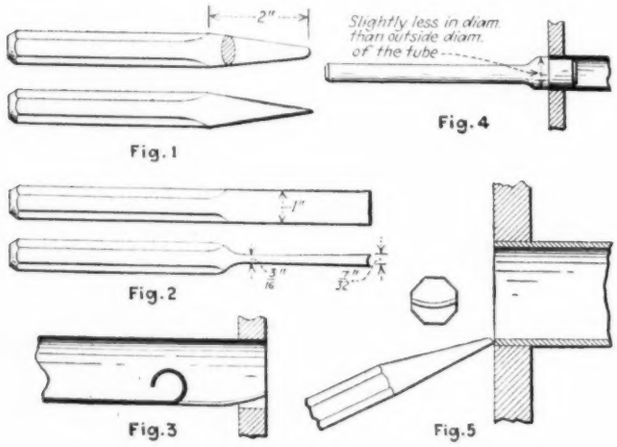
C. A. OLSON,
Assistant Engineer of Production,
Chicago, Ill. Crane Co.

* * * *

Practical Method of Removing a Boiler Tube

THE method of removing boiler tubes described by J. W. Right in the Aug. 9 issue may be an approved one, but it is different from my way, which I think is in many respects more practical.

My plan is first to cut away the beaded portion with a flat chisel, then drive in between the bottom of the



Detail of tools used in removing boiler tubes

tube and the tube sheet the point of a tool known by boilermakers as the "oyster knife." It is made as shown in Fig. 1.

The tube end is now ripped, starting at the end and continuing for about three inches, using a tool known as the "ripper," Fig. 2. When the tube is ripped, it appears as Fig. 3. The other end of the tube is now dealt with by cutting off its beaded portion or projecting end flush with the tube sheet. A driver, Fig. 4, is then inserted in the tube, and the tube is driven out.

Care must be taken not to injure the tube holes in the sheet, and to permit of the ready insertion of the point of the ouster knife shown in Fig. 1, the tube should be slightly raised by using a round-nosed tool or, better, a "cow mouth," as shown in Fig. 5. As much of the work as possible is done with an air gun.

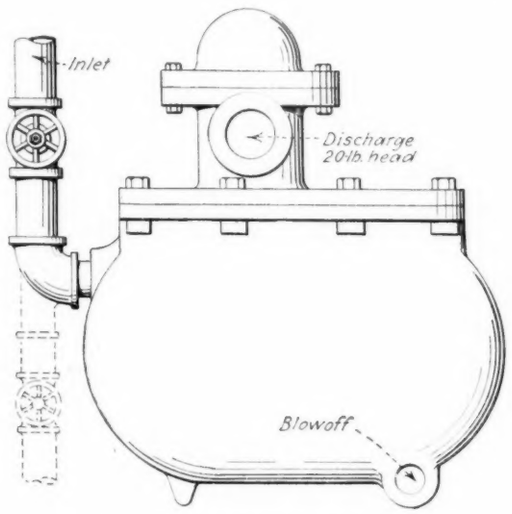
Long Beach, Calif. E. J. JORDAN.

* * * *

A Study in Traps

WHEN I was a boy (several years back) old Bill Saunders used to discuss the trap situation something like this:

"Traps have been, as far as I can discover, man's bitterest enemy. Of course I don't mean before steam was invented, but since the Dark Ages. You know most traps



Drip connected at the inlet to the trap

are supposed to have valves and seats, but some have and some have not. One of these days some bright man will make a trap without these evils, and then the engineer's life will be more pleasant."

If Bill Saunders was worried with the troubles of four traps, think of the life of an engineer who had 62 traps in his immediate charge and over 400 in the entire plant. A large number of the traps were low-pressure expansion-type; several more were high- and low-pressure float-type; and a large number were high-pressure bucket-type.

The bucket-traps in the power house and on all main and auxiliary lines were equipped with blowoff valves on the trap body, but no drip valves on the inlet side of trap. When the lines were cut off over the weekend, the blowoff valves were opened and any condensation allowed to waste through the open end. When the steam was turned on again, the blowoffs were left open until sufficient pressure was obtained in the lines to force the condensate

against the head pressure of 20 to 30 lb. By the time this condition obtained, several of the traps—38 or 40 by actual count—had no duty to perform, as the condensation was carried along in the main lines. But as the bucket was in the down position, through lack of water to float it, caused by using the blowoff as a drip, steam blew right through the valve.

Before any figuring was resorted to, the piping was changed as shown in the illustration, and then the gang compared notes as to how much would be saved by the improvement.

The boss steamfitter gave forth the information: "You can charge up 24 hours a day 5 days in the week and 8 hours Saturday, which will be conservative, as steam is on these lines by 3 o'clock Monday morning. That makes 128 hours."

The assistant engineer said: "I have got the valve openings of the various traps from $\frac{1}{2}$ to $1\frac{1}{4}$ in., and I figure the average area to be approximately 0.57998 inch. If I had figured the discharge-pipe areas of these several traps, the answer would be 27.7 sq.in. As we are approximating the result, we will use Napier's formula, letting P = 150-lb. gage, A = Area, t = 3,600 sec. = 1 hour, and W = weight per hour. Then $W = \frac{(P+15) \times (A)}{70} \times t = 165 \times \frac{0.58}{70} \times 3{,}600 = 4{,}921.5$ lb. per hour, or $4{,}921.5 \times 128 = 629{,}952$ lb. per week, and at 50 weeks per year the loss would be 31,497,600 lb. This steam costs approximately 50 cents per 1,000 lb. or $\frac{31{,}497{,}600}{1{,}000} \times \$0.50 = \$15{,}748.80$."

"Fifteen thousand dollars looks like a big piece of change," remarked the steamfitter.

"Our fuel costs us over half a million dollars per year," the assistant engineer informed us. We called the chief engineer, and he said, "You've done a good job, boys. You would do a better job if you took the traps off altogether. The lines all carry superhated steam, and there is no need of traps. As to the $15,000 you are going to save, think this one over: The trap lines discharge into the open heater and no steam is escaping from it. What's the answer?"

C. W. PETERS.

New York City.

* * * *

How Long Is The Line?

REFERRING to the problem, "How long is the line?" I believe this may be more readily solved by ignoring the angle XBC and joining C to the center of the circle. Call this center O. Call angle XOC, θ. When θ is in radians arc XC is $10\,\theta$. Attending to the triangle XCA, which can be flattened into a plane without distorting any of its elements,

by the Pythagorean theorem,

$$CA = \sqrt{\overline{XC}^2 + \overline{XA}^2} = \sqrt{100\,\theta^2 + 1{,}600} = 10\sqrt{\theta^2 + 16}$$

Consider next the circle forming the top boundary:

In the triangle BOC, $\overline{OB} = 8$

$$OC = 10$$

$$\text{Angle } BOC = \pi - \theta$$

By the law of cosines,

$$BC = \sqrt{64 + 100 - 160\cos(\pi - \theta)}$$

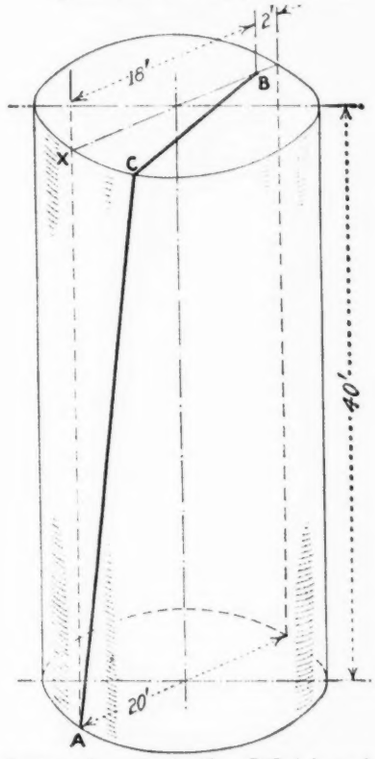
But since $\cos(\pi - \theta) = -\cos\theta$

$$BC = \sqrt{164 + 160\cos\theta} = 2\sqrt{41 + 40\cos\theta}$$

$$\text{Let } L = BC + CA = 2\sqrt{41 + 40\cos\theta} + 10\sqrt{\theta^2 + 16}$$

It is desired to make this a minimum,

$$\frac{dL}{d\theta} = \frac{-40\sin\theta}{\sqrt{41 + 40\cos\theta}} + \frac{10\,\theta}{\sqrt{\theta^2 + 16}} = \frac{-40\sin\theta\sqrt{\theta^2 + 16} + 10\,\theta\sqrt{41 + 40\cos\theta}}{\sqrt{41 + 40\cos\theta}(\sqrt{\theta^2 + 16})} = 0$$



The shortest length the line BCA is to be found

Hence $-40\sin\theta\sqrt{\theta^2 + 16} + 10\,\theta\sqrt{41 + 40\cos\theta} = 0$

or $4\sin\theta\sqrt{\theta^2 + 16} = \theta\sqrt{41 + 40\cos\theta}$

Squaring both sides,

$$16\sin^2\theta(\theta^2 + 16) = \theta^2(41 + 40\cos\theta)$$

Since $\sin^2\theta = 1 - \cos^2\theta$

$$16(1 - \cos^2\theta)(\theta^2 + 16) = \theta^2(41 + 40\cos\theta)$$

$$41\,\theta^2 + 40\,\theta^2\cos\theta - 16\,\theta^2 + 16\,\theta^2\cos^2\theta - 256 + 256\cos^2\theta = 0$$

$$25\,\theta^2 + 40\,\theta^2\cos\theta + 16\,\theta^2\cos^2\theta + 256\cos^2\theta - 256 = 0$$

The value of this function when θ_1 = 168 deg., or 2.9321 radians, is —0.90

The value of this function when θ_2 = 169 deg., or 2.9496 radians, is +0.70

By the Regula Falsi method θ_3 = 168 deg. 34 min., or 2.9420 radians

The value of the function at θ_3 = +0.02, which is as close as can be obtained with 5-place log tables.

This is the value which will make L a maximum. The value of L at this point is 52.33+ ft.

When θ = 2.9420 radians, arc XC is 29.42 ft.

The angle XBC can now be found by trigonometry.

Swedeland, Pa. JOHN A. ROULTON.

Steel Castings

I WAS much interested in an editorial on "Testing Steel Castings," which appeared in the June 14 issue of *Power*.

It is true that much difficulty has been experienced with steel castings, not only in power-plant work but in the much greater field of oil processes. It was with this knowledge that we embarked on our Sigma Steel development.

Unfortunately, Sigma Steel has been in the field only a relatively short time. Our most notable installation up to the present moment is in the East River Station of the New York Edison Company. We have kept closely in touch with this situation and authentic reports up to the present moment indicate that no fitting of this type has leaked, nor has shown any other sign of difficulty.

It is a relatively simple matter to develop patterns and foundry technique to such a point that uniformly good castings will result. Such development work pays large dividends if the pattern is to be regularly in production. It is impossible if only one or two castings are required, because the cost of the development exceeds the value of the required castings many times.

X-ray is but one link in such a process of development. The X-ray sees areas of the casting which may be a foot square. It is cheaper to take such an X-ray than it is to cut the casting up into many sections so that all its interior parts may be thus examined.

Ordinarily, the complete exploration of a casting by X-ray costs at least three times as much as the casting is worth. Perhaps some day the process of taking X-ray exposures and the equipment for so doing may be developed to such an extent that this cost will be materially reduced. There is a long road to travel, however, before the X-ray will become commercially possible as an inspection method.

The editorial stated further that in testing castings with hot water, increased temperature "opens up the metal structure as a result of its expansion, and the small flaws, cracks and pin holes are more readily detected."

My understanding of the hot-water test is entirely different. I would hardly expect that a temperature of 200 deg., or thereabouts, would seriously affect the steel structure. Is it not a fact that the object of heating the water is not to expand the steel, but rather to change the viscosity of the water to such an extent that it will pass through a smaller opening than is the case with cold water?

We have repeatedly applied the hot-water test to Sigma Steel castings. It is not a difficult test to make. It requires only a heat exchanger between the pump and the fitting being tested. The statement that the hot-water test "results in a higher percentage of rejected castings" is generally correct. Our experience shows, however, that it is not correct so far as we are concerned. We are "reluctant to standardize on this test" not because of fear of rejections, but because of the fact that the testing operation is slowed up, due to the fact that the casting is hot and that the water must be allowed to flow through the casting until that entering the casting, and the casting itself, are both at the testing temperature.

F. H. MOREHEAD, Chief Engineer,
Boston, Mass. Walworth Company.

Answers to What Do You Know

The questions are on page 635

Ans. 1—The Corliss would develop the most power. The early beginning of compression in the uniflow cuts off the indicator diagram area at the heel, and this indicates a reduction in power greater than the increase brought about by the longer actual cutoff in the uniflow due to its greater clearance. Under certain conditions of exhaust the clearance of the uniflow is the same as the Corliss, and in this case the actual cutoff is the same.

Ans. 2—The compression exponent of a gas is a function of the number of atoms in its molecule. For diatomic gas like air the exponent is about 1.4, for tri-atomic gas, such as CO_2 and SO_2 it is about 1.25, and for multi-atomic gases like ethyl-chloride, C_2H_5Cl, it falls off to about 1.1, and the temperature rise is less.

Ans. 3—The difference between the theoretical or synchronous speed and the actual full-load speed. The theoretical speed is equal to the product of the line frequency times 120 divided by the number of poles in the machine. Thus, a 60-cycle four-pole motor has a synchronous speed of $(60 \times 120) \div 4 = 1{,}800$ r.p.m. If the motor operated at 1,730 r.p.m. at full load, the slip would be $1{,}800 - 1{,}730 = 70$ r.p.m.

Ans. 4—No. The indicated level will become higher than the real level in the boiler. This is for the reason that the steam in the glass will condense and, as the bottom connection is closed, this condensed steam is trapped in the glass, raising the level above the boiler level.

Ans. 5—The friction between the moving vane and the packing seals will develop enough heat to damage the parts.

Ans. 6—The total pressure at 35 deg. would be 87.36 lb. gage. If the ammonia at 80 deg. F. exerts a pressure of 138.3 lb. gage, or 153 lb. absolute, the air at 80 must exert $203 - 153 = 50$ lb. abs., since the total pressure is the sum of the two pressures. By cooling to 35 deg. F. the ammonia pressure drops to 51.6 lb. gage, or 66.26 lb. abs. The air also drops in pressure, the pressures and temperatures having the relation $\frac{P_1}{T_1} = \frac{P_2}{T_2}$, assuming the volume is constant, this being approximately true. The pressure P_2 at 35 deg. F., or 495 deg. F., will be 45.8 lb. abs. The total pressure in pounds absolute will then be $45.8 + 66.26 = 102.06$, or 87.36 gage.

Ans. 7—Triple-expansion vertical crank-and-flywheel engines have given results unobtained by any other steam engine under like conditions of steam pressures.

Ans. 8—Heat the links with a welding torch flame, which will heat the links so quickly that the rim will stay cool.

Ans. 9—Every piece of material has a natural period of vibration, or, in other words, it vibrates like a tuning fork so many times a second. This is its critical, and if the speed at which the shaft turns is equal to the vibration period, it may vibrate so violently as to wreck the machine.

Ans. 10—The tendency on the part of the fireman is to carry the fire thick near the doors and thin at the bridge wall. By making the grates sloping the fireman is deceived as to the thickness of the fuel bed, so keeps it thick enough at the bridge wall.

Powdered Coal for Small Boilers

FEATURES of design that tend to make up an ideal unit-pulverizer installation for boilers having up to 5,000 sq.ft. of surface and some of the common mistakes that have been made during the last few years, ers Committee, Great Lakes subcommittee on Development of New Apparatus, Prime Mov- as brought out in a report of the Division, N.E.L.A.

ECONOMIC situations favoring the use of powdered coal may be listed as follows: High- or medium-pressure boiler plants that have use for low-pressure steam for heating or process work; where considerable labor may be saved; where sized coal is required for existing equipment; where an increase in capacity is wanted; where long banking periods are necessary; where extreme flexibility is desired, and where the market offers coal of widely different burning characteristics.

A plant equipped with high- or medium-pressure boilers, where low-pressure steam is used for heating or process work, is the most satisfactory situation of all. Here the pulverizers may make use of turbine drive, the turbine functioning in lieu of a reducing valve. In such instances the gross and net efficiencies are virtually the same figure. Hotels, laundries, greenhouses, schools, knitting mills, central heating plants, breweries, etc., fall under this class. In special cases economies as high as 60 per cent have been effected.

Much Labor Saved By Proper Layout

Often considerable labor can be saved in the small plant by the adoption of a properly designed powdered-coal layout. Where mechanical coal- and ash-handling equipment is provided, one man easily can look after several boilers. Where lump, egg or mine-run coal is required for existing equipment, there is usually in excess of a dollar per ton from which to extract a saving, by the use of screenings. The increased efficiency of powdered coal over hand firing cancels the difference in heat value between the lump coal and the screenings, and the saving in labor may cancel the cost of power purchased to operate the pulverizer.

Draft requirements of a powdered-coal furnace are less than those for natural-draft stokers. The demand for increased capacity may therefore be a consideration, and the unit pulverizer may solve this problem and at the same time bring in other advantages.

Where long banking periods are encountered, as in standby boilers, the unit pulverizer is filling a long felt need. With a properly insulated boiler, there is sufficient heat in the setting to hold steam in the boiler for a period of ten to twelve hours. A dead boiler can be put on the line with extreme rapidity. About one-fifth the fuel is required to bank a powdered-coal furnace as is necessary for most stokers.

Where extreme flexibility is desired, the properly designed unit pulverizer installation can go to any extreme desired with little drop in combustion efficiency. At the plant of a greenhouse in Chicago, with only one burner per boiler, satisfactory performance is secured from 1,600 lb. of coal per hour down to 80 lb. of coal per hour. A flexibility of 20 to 1.

The ability to burn either coking or non-coking, high-volatile or low-volatile coals with equal satisfaction is inherent with powdered-coal plants. Moreover, the powdered-coal plant is the only one that is not affected by the preparation given the fuel—whether it runs coarse or fine.

Sources of Trouble

Experiences over the last few years indicate that trouble has arisen from the following sources: Solid walls and floors; water and air-cooled walls and floors not properly designed; improper relation between flame and furnace; failure to expose maximum tube or shell surface to the furnace; improper introduction of secondary air; burners of poor design; difficulties involved in dividing a stream of powdered coal and air equally to two or more burners, and the lack of a satisfactory unit pulverizer.

For several reasons solid walls and floors generally have proved unsatisfactory in the Middle West. The fusing temperature of the ash is either medium or low. The chemical characteristic of this ash is strongly basic, while that of the refractories is usually acid. With the high temperatures encountered this chemical affinity dooms the installation to operate at low capacity or suffer high maintenance. Even for capacities up to 200 per cent builders' rating, slag troubles usually are encountered where Midwestern coal is used.

Where solid walls are permissible, as in the case of low rates of combustion, or when the wall is screened by water tubes, provision should be made for expansion strains. Among other things the life of a setting depends on its freedom from expansion strains; therefore, the fire lining should be able to expand independently of the outside walls, and the foundations should be kept at a temperature near that of the outside walls and steelwork.

In the design of an air-cooled wall the fundamental principle involved is that of a heat exchanger. The fact must be borne in mind that air does not receive heat by radiation. When air flows horizontally along a vertical hot surface, there is a minimum cooling effect. Where the air flows upward around surfaces projecting into or across the air space, the cooling effect is greatly increased, owing to the impingement of air on the hot surfaces.

It is obvious that heat must be conducted from the heat-absorbing surface to the heat-dissipating surface before it can be transferred to the cooling air. The thickness of firebrick through which this heat must be conducted will therefore modify the efficiency of the wall as a heat exchanger. Data have been presented showing that a 9-in. firebrick wall with a furnace temperature of 2,400 deg. F. will conduct 1,900 B.t.u. per square foot per hour to the outside surface. At the same furnace temperature a 4½-in. firebrick wall conducts 3,600 B.t.u.

Considering dependability and durability, it would seem that all walls on the market today will give satisfactory performance from a structural viewpoint, provided they are properly installed with due provisions for expansion. Most air-cooled walls fail because of low cooling efficiency which leads to spalling and slagging.

Effectiveness of Water-Cooled Side Walls

Water cooling of side walls is probably ten times more effective than air cooling, based on equal projected areas. However, the increase in first cost is about in the same ratio as the effectiveness. Trouble has been encountered where water conditions are unfavorable and tube failures have been reported in plants having excellent water. In general, however, water-cooled walls have given good satisfaction.

Troubles have arisen from improper relations between flame and furnace. A long flame should be made to traverse the long axis of the furnace. A narrow furnace should have a narrow flame. A short, wide furnace should have a short, wide flame. In general it would seem that at all times the flame should be as short as local conditions will permit. At the same time, furnaces should be as large as is economically possible and full advantage should be taken of such inherent features as the shape of the boiler and the depth of the basement. Large furnaces go a long way

toward recovery of ash, and there is no doubt about their ability to handle coarser coal than is possible in small furnaces.

Failure to expose maximum tube or shell surface to the furnace, leading to high furnace temperatures and limited capacities, is encountered more frequently where vertically baffled boilers are served by narrow vertically fired furnaces. Little new work of this type is now being installed, and there is a decided trend toward horizontal firing for all classes of boilers whose capacities fall within the scope previously given in this report.

In the admission of secondary air lies the stumbling block of many an otherwise excellent installation. The basic principles involved are simple enough. The gases in the furnace are about one-fourth to one-fifth as dense as is the air admitted to the furnace through the secondary air openings. In fact, they bear about the same relation to each other, in the matter of weight, as does water to molten iron. When secondary air is introduced into a furnace, it is acted upon by gravity in the same manner, and to about the same degree, as a stream of molten iron pouring into a tank filled with water. Secondary air inlets should not be placed underneath horizontal burners, and in vertical firing the flame should be near enough to the front wall openings to render the secondary air effective.

Turbulence and Short Flame

In burner design, most manufacturers now recognize the vital necessity of turbulence in the combustion of pulverized coal, and the necessity for short-flame combustion. At present the flexibility of these burners is about 4 to 1. For most central-station work this is sufficient, but in industrial and heating plants greater flexibility is often desirable.

In installations where open-pipe burners or long-flame burners are being used, or where, in order to make full use of the available furnace volume, it is desirable to have several small flames instead of one large one, it has been a relatively simple matter to divide the stream so that equal volumes of coal will be delivered to each burner, and it is equally easy to divide the air accurately to each burner, but the real difficulty is to deliver equal volumes of air and coal to each burner at the same time. A number of installations have been observed where dampers and deflectors were the only means employed to distribute fuel to two or more burners. In no case was this accomplished in a satisfactory manner, and it would seem that the logical solution to this problem would be to develop a burner that can be adapted to different-shaped furnaces and that can handle the entire quantity of coal with a sufficiently short flame, and thus eliminate entirely the necessity for a splitting or proportioning device of any kind.

The six requisites that go to make up an ideal unit pulverizer are fineness of grind, uniformity of feed and delivery, low upkeep, low power consumption, flexibility and ability to dry coal in the mill with preheated air.

Most of the impact mills start out with fine grind, and as the hammers wear the percentage of coal that stays on top of a 50-mesh screen gradually increases until the wearing parts are again renewed. Some impact mills have corrected for this by the use of classifiers and have thus made their mill conform to the first requirement of a satisfactory pulverizer. Tube mills inherently satisfy this requirement, as the fineness of grind from this type of mill does not change as the grinding elements wear.

Uniformity of feed and delivery is a requirement that does not seem to be met fully by any of the unit pulverizers as installed by the manufacturers. The results are a ragged CO_2 line, intermittent smoking, high carbon loss in the third pass, and very often intermittent slag trouble.

Importance of Maintaining Low Upkeep

Low upkeep is considered next in importance, and along with the cost of renewing wearing parts, the item of labor for making the renewals, as well as the outage charges, must be included. Some of the unit pulverizers are being designed with a view to facilitating the renewal of wearing parts. The tube mill is ideal in this respect, for all that is necessary to renew the grinding parts is to throw in a few steel balls. There are impact mills, on the other hand, that require the labor of two men for six hours to renew a set of hammers. Most of the mills on the market today, however, can be rehammered in thirty minutes or less.

Power consumption varies widely with various fuels. With Midwestern coals the average figures seem to vary from 16 to 22 kw.-hr. per ton. Figures of 8 to 11 kw.-hr. per ton appearing in advertising matter are obtained for the most part with Eastern coal. In sales analyses there seems to be no difference made between inherent moisture and surface moisture. It is the surface moisture alone that affects the grinding cost, as the inherent moisture can vary over the widest ranges with no effect whatever on the power consumption of the mills.

Increased Fineness of Grind Means Increased Power

Increasing the fineness of grind rapidly increases the horsepower, so that with most impact mills starting out with a fine grind, the power consumption is high and then decreases, as the hammers wear and the grind coarsens, down to a certain critical point from which, if the hammers wear still more, the efficiency and capacity of the pulverizer drops off rapidly and the power consumption again mounts.

It is, of course, useless to make a pulverizer more flexible than the burner it serves and, conversely, it is useless to design a highly flexible burner to use with a pulverizer that has a small range of regulation. In most unit pulverizers the air is controlled by throttling the air inlets to the pulverizer. This method builds up a high negative pressure at the feeder and causes the coal to be pulled into the pulverizer in an erratic manner, with the result that when low ratings are attempted, the combustion conditions are so irregular as to be entirely unsatisfactory. A regulation limit of one to four is standard among most manufacturers, and where there are a large number of boilers, this range of regulation is sufficient. However, in industrial plants and particularly in heating plants, situations are encountered often where the widest range of regulation is desired.

In fairness to the pulverizers now on the market, it should be stated that most of them have flexibility materially in excess of most of the burners now in use. Usually, the simple expedient of introducing a damper or valve between the pulverizer and the burner will give any degree of flexibility desired. In all probability the near future will see more burners designed to take advantage of this important characteristic.

Using Preheated Air for Drying

The practice of using preheated air for drying the coal in the mill is almost universal. Those mills that do not use preheated air can be changed easily to do so. The chief advantage is to permit the use of wet coal without an excessive falling off of mill capacity. Temperatures as high as 700 deg. F. have been used with very wet fuel without overheating the pulverizer bearings, and Midwestern fuel with its normal mine moisture will take the air up to 400 deg. F. without causing trouble. In most small plants the preheated air is taken from air-cooled walls or floors. There are instances, however, where hot gases are bled either directly from the bottom of the furnace or from the uptake of the boiler. The use of hot flue or furnace gas, however, is an expedient that should be resorted to only when sufficient preheated air from other sources is not available. In general, the use of a drier does not appear to be justified with unit pulverizers.

Pulverized Coal No Panacea

It is evident that a large number of uninformed individuals are looking upon powdered coal as a panacea, and the well-known national weakness of embracing fads is likely to cause installations to be made where the economic conditions do not warrant such action. Where pulverized coal firing is under consideration, too much care cannot be exercised in dealing with both the economic aspect and the various engineering phases of the problem involved in each particular case.

A New Theory for the Centrifugal Pump

By A. F. SHERZER
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THIS abstract of a paper presented before the American Society of Civil Engineers points out several errors in the present-day theory of centrifugal pumps.

A REVIEW of the literature on centrifugal pumps indicates that the theoretical working equations may be derived, in general, from two distinct lines of approach. One of these seems to be held in especial favor by European writers, particularly in Germany, and is based on the application of Bernoulli's theorem to the flow through the pump. The other is often found in works of British and American origin, and is based on the laws of angular momentum.

The derivation contained in the text of several authors contains a most important and interesting error, which contributes largely to the defects in present pump theory. It reads as follows:

$$h_a - \frac{W_a^2}{2g} = h_1 + \frac{W_1^2}{2g} + p_1 h_n$$

This is merely the application of Bernoulli's theorem to the problem, where h_a is the pressure head in the fluid at point a and W_a is the absolute velocity of the water discharge from the impeller at point a; while h_1 is the pressure head at 1, the entrance to the guide-vanes, a short distance from point a, and $\frac{W_1^2}{2g}$ is the absolute velocity head at 1. The term, $p_1 h_n$, represents the hydraulic losses occasioned by the flow from Points a to 1.

It is commonly considered that the total head at a is composed of a pressure head, h_a, and, in addition, a velocity head, $\frac{W_a^2}{2g}$. When the pump discharge is approximately zero, the pressure head h_a, is very nearly $\frac{U_a^2}{2g}$, where U_a is the peripheral speed of the impeller at its outer diameter. Under the same conditions the absolute velocity W_a approaches the peripheral speed of the impeller or U_a, and the head becomes $\frac{U_a^2}{g}$.

This theory leads to a discrepancy between theory and practice of about 100 per cent.

The usual explanation of this discrepancy indicates a serious misconception not only of the action of the centrifugal pump, but also of one of the fundamental laws of hydraulics. The error is due to a misapplication of the well-known Bernoulli theorem.

When water flows in a pipe it is customary to say that the total head is obtained by measuring the pressure head by a piezometer at right angles to the flow, and adding the velocity head. This is a correct application of the theorem, as the pressure and velocity exist as separate and distinct factors. When water, however, is set in rotation in a cylindrical vessel by the action of an impeller, there is a pressure created by centrifugal force which is equal to $\frac{U_a^2}{2g}$, and which is part and parcel of the velocity itself. The total head may be regarded as either but not both. The pressure exists merely because of the velocity in the circular path, but certainly not in addition to it. Thus at "shutoff" a pump gives a head of only $\frac{U_a^2}{2g}$, instead of $\frac{U_a^2}{g}$, as required by all present theories.

OBJECTIONS TO GUIDE VANES

One of the questions debated for years by centrifugal pump designers concerns the use of guide vanes. Some state that it is always possible to secure better efficiency by their use, while others would never design a pump with guide vanes.

In order to answer this question, consider what is supposed to be their function. It has been shown in the derivation that after discharge from the runner the water has a pressure head, as well as a velocity head. It is often stated that this velocity head will be lost in shock, friction, etc., unless suitable provision is made for its recovery. The commonly accepted idea has been that at very small rates of flow this energy is about equally divided between pressure and velocity, and that the entire velocity head under these conditions was likely to be lost unless special provision was made in the form of guide-vanes or diffuser vanes. Such vanes were designed so as to receive the absolute velocity of the water, and by increasing the area of the water passages between them, the velocity was expected to be converted most efficiently into pressure.

Evidently, from the previous discussion, the use and benefits of guide-vanes are founded on a misconception of the theory. In a centrifugal pump it is wrong to assume that the total energy is represented by the pressure in the casing, plus the kinetic energy of the absolute velocity of discharge. As the water is confined to a circular path, its kinetic energy is necessarily converted into pressure without any assistance from the guide-vanes. In fact, they often serve to obstruct the natural flow of water, which entirely defeats their purpose and renders them useless.

PURPOSE OF CASING

What has just been said with regard to the use of guide-vanes may also be extended to include the so-called volute or spiral casing into which the runner discharges. The advantage of the volute casing is supposed to lie chiefly in permitting the efficient conversion of velocity into pressure through the recovery of a part of the energy represented by the absolute velocity of discharge from the runner.

While it is true that velocity is converted into pressure in the casing, yet it is not at all in the manner or for the reasons usually given. If a body of water is set in rotation so that the peripheral speed of the outermost particle is V, then a pressure will be developed equal to $\frac{V^2}{2g}$, a case of perfect conversion of velocity into pressure. This is exactly what is taking place in the centrifugal pump.

Apparently, the only function of the casing is to restrain the water and compel it to move in a circular path. The development of pressure then follows naturally. The very existence of pressure here indicates clearly that the velocity has been converted into pressure. It is difficult to see how it can be done a second time, yet this is exactly what is supposed to be accomplished by guide-vanes and spiral casings.

ACTION AFTER FLOW BEGINS

Consider a pump running at a certain speed, but with its discharge valve closed. The water in the impeller and the casing is set in rotation, creating

a pressure in the pump, but flow from the runner is prevented owing to the pressure of the water in the casing. Now, assume that the discharge valve is opened a trifle to permit a slight amount of flow. The pressure in the casing falls, and the pressure opposing the flow from the impeller decreases, but the centrifugal force tending to throw the water out of the impeller remains the same since the speed of the pump is constant.

Consequently, water will flow in from the impeller into the casing, the quantity depending on the difference in pressure as well as on the area of the water passages. As soon as the water begins to move relative to the impeller, friction comes into play opposing the flow. The pump will adjust itself to these conditions so that the resultant of the pressure in the casing, the drop in pressure due to the flow, and the frictional losses in the impeller will equal the total pressure due to centrifugal force. From now on the pump will operate continuously at this discharge.

On further opening the discharge valve similar readjustments continue until the entire pressure due to centrifugal force has been consumed in forcing the water through the runner, or else a point is reached where the atmospheric pressure is no longer able to force any greater quantity of water into the suction of the impeller. Thus, the flow from the runner is simply governed by the difference between the pressure due to centrifugal force and the pressure in the casing. Once this is clearly understood, the problem is merely that of the flow through a very special form of orifice due to this pressure difference.

Hence, the entire problem of the centrifugal pump is that of flow through three orifices in series. The first is at the suction entrance to the impeller; and this determines the maximum capacity of the pump. The second is at the discharge from the runner, and the third is at the throat of the pump. Each of these orifices or points of restriction has its own characteristics and their combined effect determines the pump characteristic.

Application of the Theory

The application of this theory is clearly shown in the paper by a complete calculation of a pump characteristic curve. The head-capacity curve as calculated was found to agree closely with the pump characteristic as determined by test.

In order to further substantiate the principles developed with this new theory, a 4-in. pump was designed and built in accordance with these new ideas. This pump was not particularly different from those ordinarily found on the market so far as general appearance went. It did differ, however, to a marked degree in the design of the various hydraulic details. It was a single-stage pump with neither volute nor guide-vanes. The runner was set concentrically in a casing of constant circular cross-section.

The performance of this pump, as determined by tests at the University of Michigan, indicates a maximum efficiency of 79 per cent at a capacity of 330 gal. per min. and a head of 67 ft. at 1,450 r.p.m. It is believed that this establishes a record for both American and European practice for a pump of such capacity. The usual efficiency obtained under such conditions is only about 60 per cent.

Several other pumps of 3-in. size, having different characteristic head curves, were also made and tested at manufacturers' plants. The results of these tests also showed high efficiency and high head performance.

Discussion of this paper brought out the fact that one manufacturer had been able to design pumps with volute casings to give efficiencies equaling those obtained by the pump designed by Professor Sherzer. This manufacturer had designed a 4-in. pump of similar capacity and characteristics that gave an efficiency of 77 per cent, and a 3-in. pump of similar size and capacity to the 3-in. pump designed by Professor Sherzer, that gave an efficiency of 83 per cent, as compared to 79 per cent obtained in the new design. This would seem to indicate that with extremely careful design of volute and pump passages equal efficiencies can be obtained with either the volute case or the circular casing as designed by Professor Sherzer, and based on his new theory of centrifugal pumps.

Smoke Abatement Session at St. Louis

THE final session of the First National Fuels Meeting at St. Louis, the technical sessions of which were reported in *Power* for October 18, was concerned with the subject of smoke abatement.

George T. Moore, director of the Missouri Botanical Garden, described a number of ways considerably more accurate than the soot-fall method of measuring atmospheric pollution. These methods included the use of the Owens automatic air filter and the jet dust counter. Some mention also was made of methods of measuring the acidity of the air, the sulphur dioxide content and the detection of the presence of pathogenic organisms.

Smoke-abatement methods used in Cleveland to reduce industrial, railroad and marine smoke, were reviewed by Elliott H. Whitlock, commissioner of smoke inspection for the City of Cleveland. Attention was called to the ambiguities in smoke ordinances and the need for the establishment of certain physical relations to be recorded with the ordinances, such as the maximum size of a boiler to be allowed with hand-fired grates, setting heights and the exclusion of certain types of equipment that are impossible or difficult to operate without smoke. Some attention was given to the use of steam-air jets, the astounding lack of uniformity in chimney sizes, and to the desirability of installing instruments and using them with intelligence. The department believed that smoke abatement could be "sold" to smoke offenders on the basis of an economical investment. In the way of education, for the last year and a half in Cleveland there has been conducted a night school course for firemen, which has been attended by more than 100 students.

Erle Ormsby, president of the Citizens Smoke Abatement League of St. Louis, told how a campaign should be organized and conducted. In his opinion co-operation was the magic watchword, and the success of the movement would be just in the proportion that universal co-operation was secured. One of the essentials was to get the engineers of the city interested and organized into a technical division, with subcommittees for each fuel-consuming class. The speaker outlined the activities of this technical division, enumerated the studies to be included in a smoke survey, emphasized the importance of research, educational and publicity work, and in this connection reviewed what had been done in St. Louis.

"Smokeless and Efficient Firing of Domestic Furnaces," by Victor J. Azbe, was a paper of interest to the heating engineer, for in it data of tests conducted over a period of two years on the firing of domestic furnaces were presented. Mention was made of a new method of vertical baffling, dividing the furnace into coking and combustion zones, resulting in practically smokeless combustion of bituminous coals.

As a fitting climax to a day on smoke abatement, Prof. A. S. Langsdorf, director of industrial and engineering research, Washington University, summarized opinions from current literature on the effect of atmospheric smoke pollution. This paper indicated the danger of smoke to many living organisms, including human beings, and urged that efforts be made to obtain, at regular, frequent intervals, analyses of air samples taken at numerous stations in cities throughout the country. The reasons for the ill effects of smoke on health were given and reports from various cities cited.

Long-Time Guarantees of Prosperity*

By Edward J. Mehren

Vice-President of the McGraw-Hill Publishing Co., New York

THERE are obviously many factors in making prosperity, and if exact definition be insisted upon, one must admit that there can be no absolute guarantee of unbroken high-speed business. But there are certain fundamental factors.

It is all the more important that we appreciate these fundamentals at the present time, for we are in a period of severe test of business and business men. We are in an era of large though now declining volume of business, but of falling prices and narrowing profits. True, the price index has recently turned upward, but the business man who plays safe will remember the price trend after the Civil War and make his plans on the assumption of a long though gradual decline.

America's Production

To begin with, let us get a picture of America's recent industrial development. The last United States census of manufacturers showed that the volume of our manufactured goods in 1925 was $2\frac{3}{4}$ times that of 1899, but that the number of men employed was only 1.8 times as great. In other words, there has been a great increase in output per worker; in fact, each man now produces 50 per cent more than he did in 1899. The reason is that we now use $3\frac{1}{2}$ times as much power as we did 28 years ago. We have transferred the work of industry from the backs of men to the inanimate forces of steam and electricity.

As a result of the use of power and machinery, therefore, 67 men now do as much work as 100 men did before. If today we produced only the same kinds of goods as in 1899, the country could not absorb them, for the population has increased only 54 per cent, whereas the goods production is $2\frac{3}{4}$ times as great. True, with a higher standard of living people formerly in poverty would buy more staples, but the demand would not absorb the entire 33 per cent of labor thrown off by the staple industries. We should have one of two things or a combination of them. We would have large unemployment, with resulting poverty and its attended discontent, or we should be dividing among 100 the wages that now go to, say, 67. In the latter event we should have a lower standard of living, on account of the reduced purchasing power per capita. In either event, instead of prosperity we would have industrial stagnation, the ills of overpopulation and all those serious social problems that beset England and that Mussolini is grappling with.

Where, then, have gone these men thrown off as surplus labor by the older industries? The answer is that they have gone into new industries and are making products undreamed of in 1899. That important phenomenon is at the bottom of our prosperity, and if we understand how it has occurred and what has made it possible, we shall know some of the long-time guarantees of prosperity.

Radio, for example, comes on the market. It is sold to the whole people in five years. The national mind in that brief period becomes radio conscious and accepts the new product as a normal element in community life.

The first long-time guarantee, then, of prosperity is the preservation of this adaptability and receptivity of the American people. The primary means of preserving it is to continue to raise the level of intelligence of our people, and this demands a continuance of liberal support of our educational system. A second means is to give the public opportunity to exercise this faculty.

Research

Let us get an idea of what research can mean to an industry. The whole electrical industry is built on the research laboratory. Out of it have come the modern electric generator, high-tension transmission, long-distance telephony, radio, wire and wireless transmission of photographs, and many other wonders, too technical to interest the layman, but essential to the functioning of the electrical devices we do know.

The chemical industry, too, rests on the laboratory. Need I do more than mention aniline dyes, rayon, bakelite products, dry-ice, nitrocellulose lacquers, petroleum cracking, the fixation of nitrogen from the air, and the liquefaction of coal into oil?

But research has another and vital purpose, namely, to decrease the cost of production and thus the selling price.

This research, with which we are fairly familiar, may, for convenience, be called industrial research, for it aims at definitely conceived objectives. It is good, but far from sufficient by itself. Back of it must be another type of research, deeper in character, concerned with pushing back the boundaries of the unknown. It explores. It finds new lands in the domain of science. It breaks up matter and determines its law. It subdues forces. Here in this field, will be written the great future romances. Before giant electric power units could be there had to be the work of Ohm, Volta, Henry, the physicists who determined the laws of electricity; before radio there had to be Clerk Maxwell, the mathematician, and Hertz, the physicist; before the automobile, there had to be Carnot, who determined the law of the heat cycle on which the automobile engine is built. Industrial research, then, stands on the shoulders of pure research —on the work of the physicists and the chemists. In well-organized laboratories the two types of inquiry go together. It is often hard to tell where the one leaves off and the other begins.

I make no apology for pleading for bounteous support of research. You are building for the future. I hold out to you a promise—future industrial success, if you employ research; and I hold out a threat—industrial lameness and decay, if you neglect it.

Purchasing Power

So now we have two long-time guarantees of prosperity: First, the maintenance of a receptive market; second, research for the creation of new products. Then what? Obviously, the receptive market must be able to buy the new products as well as more of the old. That brings us to the question of purchasing power.

There are two ways of increasing purchasing power: First, by reducing prices so that the present salary and wage dollar will buy more goods; second, by increasing the number of salary and wage dollars. We are using both methods in this country. Improvement in management, elimination of production wastes, simplification of varieties in all manner of products, standardization of materials and parts, and last, but not least, research—all these are mechanisms that we are applying and that lead to lower production costs, lower selling prices and constantly higher purchasing power of the dollar.

Flow of Goods to Market

The next step after increasing purchasing power is to provide for the economical flow of goods from the manufacturer to the public. Manufacturing economy requires mass production, and mass production requires mass distribution. Here we come back to research. The area for the recovery of wastes in distribution is possibly larger today than in production, but it will yield economies only by experiment, study and research.

We have then, this recurring sequence: We use continually more power and machinery, and as a result increase the output per worker. This, in turn, has two effects: First, it increases the workers' earnings, and, second, because fewer men are needed throws off a surplus of labor. This surplus must, then, find employment in new industries whose product will be bought by the workers whose earnings have been increased. The crux of the situation, then, is to continue to increase the output per worker and to find new products to absorb the surplus labor thrown off by the older industries.

*From an address before the Chicago Association of Commerce, October 19, 1927.

NEWS *of the* FIELD

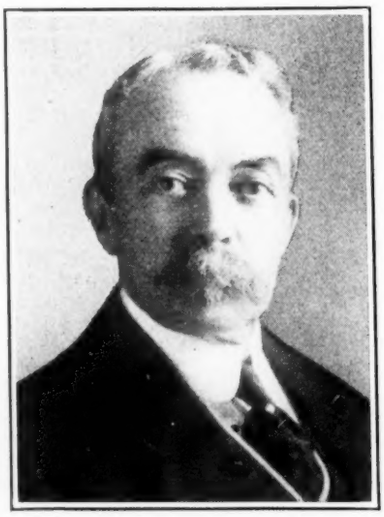
E. D. Adams Reports Mission to Louvain Fifth Centenary

Members of the Engineering Foundation, representing the four engineering societies, received with enthusiasm the address of Dr. Edward Dean Adams, vice-chairman of the board of the United Engineering Society, at a dinner at the Union League Club, New York, Oct. 20, marking the American engineers' official participation in the fifth centenary celebration of the University of Louvain, Belgium, June 28 and 29.

On this occasion Doctor Adams reported his mission as delegate of the Founder Societies and the Engineering Library, and described the post-war conditions of the ancient Belgian center of learning, proposing that a clock and carillon or set of bells for the tower be presented by the Foundation in memory of American engineers who died in the World War. Emphasizing his deep appreciation of the honored way he was received by the King and Queen of Belgium, dignitaries of the university and others, and touching on the pressing need of fully restoring the vast library to carry on its work of centuries, Doctor Adams said in part:

Proclaimed Our Co-operation

"Participation by four national American engineering societies through their Engineering Foundation in an anniversary of international significance in higher education, so brilliantly celebrated, afforded an opportunity to proclaim widely the desire of the engineers of our country to co-operate with engineers of other countries for the advancement of learning, for the better utilization of the physical and human resources of the world in benefiting mankind, and for the maintenance of peace. Renewed emphasis has been put upon the place and the possibilities of applied science in the evolution of man.



Dr. Edward Dean Adams

"Our Belgian friends and those from other countries were keenly interested in this achievement of permanent joint means for a variety of purposes by four great technical societies while maintaining vigorous individual existence and carrying on independently activities in their several fields. The fact unquestionably reflected great credit upon these societies."

Plants Memorial Trees

Doctor Adams introduced a unique feature into the celebration, the giving and planting of four seedlings of Sequoia Gigantea as memorials of the participation of the four American Engineering Societies in the fifth centenary of Louvain University. These four little California redwoods were planted by Doctor Adams and his grandson, Kempton Adams, in front of the new engineering building and will be known as the Engineering Sequoias.

Two items are lacking, for which provision should be made before the dedication next spring or summer. In the tower of the building are places for a four-dial clock, striking the hours and quarters, and for a carillon. Here is an opportunity for American engineers to have a definite part in cementing the friendly, enduring bonds and to give

Engineers and Friends at the Fuel Meeting Banquet, Hotel Statler, St. Louis, October 10

expression to their highest sentiments. As the Engineering Sequoias raise their evergreen crowns slowly skyward, the clock bells would chime the hours of continuing co-operation and the carillon would play "America" with the anthems and carols of "les Pays bas."

Resolutions endorsing Doctor Adams' proposal of gift which will cost approximately $70,000, and a special resolution of thanks for his mission were unanimously agreed upon. He had made, for the celebration, a composite emblem embracing the insignia of the four societies. This he wore on the occasion. That he should retain a replica of this emblem was also promptly agreed.

Among other prominent engineers who contributed to the great success of the impressive evening were Bradley Stoughton, who spoke on alloy and heat treated steels and their development in application, urging that a series of studies be promptly undertaken; and William H. Patchell, noted British engineer, past president of the Institute of Mechanical Engineers, London, who sketched the work along these lines undertaken in England.

Commerce Body Urges Tax Cut and Lower Postal Rates

Pursuant to a new plan, about 400 members of the United States Chamber of Commerce met at West Baden, Ind., October 15 for a four-day meeting of sessions of committees, councillors and members of the board of directors.

Of first importance were reports on Mississippi flood control, tax reduction, reduction of postal rates, maintenance of the integrity of the Federal Reserve System, self regulation by business, and the part played by member organizations in legislation and the relation of these organizations to the public and the press. Twenty different committees held meetings, reviewed the progress of their work, and, where advisable, laid out new plans.

In tax reduction the Chamber is now asking member organizations to vote on a suggestion that the corporation income tax be reduced from 13½ per cent as now to 10 per cent. The Chamber's committee, as already announced, asks a total tax reduction of $400,000,000. Reductions advocated include the abolition of the federal inheritance tax and excise taxes imposed as war measures.

The committee on postal service advocated the elimination of the higher rates made effective in 1925 on private mailing cards and circular matter, and also war rates on advertising in magazines and newspapers. This committee showed that the Post Office Department has lost revenue through these increases and that the existing rates are handicapping business.

Judge Edwin B. Parker, chairman of the board of directors of the Chamber, advocated regulation of business by itself, asserting that if it does not do so, the government will. He commended the helpful attitude of the Federal Trade Commission in desiring to assist business to work out rules of business conduct in the interest of business itself, but in a manner to safeguard the interests of the general public.

Power Transmission Men Adopt "Drive Right" Slogan

A. W. Moseley, mechanical engineer of the Sloan Valve Co., Chicago, won the contest conducted by the Power Transmission Association for a slogan. Mr. Moseley's winning slogan is

A. W. Moseley

"Drive Right" and was the unanimous choice of the judges for first place. The judges were: L. C. Morrow, R. R. Leonard, and H. D. Edwards, all members of the A.S.M.E. The new association is made up of manufacturers who are interested in mechanical power transmission. The final design and emblem embodying the slogan will be adopted by the association at the annual meeting, December 7, at the Hotel Commodore, New York City.

Way of Refrigeration Saving Topic at New York Meeting

In a short talk at the October 17 meeting of the New York Section of the American Society of Refrigerating Engineers, Willis H. Carrier, president of the Society, pointed out the need of closer co-operation between the local sections and the national organization. The main discussion of the evening, following a dinner at the Park Central Hotel, was by L. L. Lewis, who presented in an interesting way the refrigerating economies that are possible in theater ventilation systems by causing a portion of the return air to bypass the air washers. This system not only decreased the amount of refrigeration required, but brought about lower humidity conditions without retempering with steam heat.

After the session the section made an inspection of the ventilating equipment of the Roxy Theater and later attended the performance.

New York Central To Serve 25 Buildings in N. Y. Central Group

Announcement has been made by the New York Edison Co. of the signing of an important contract between the Edison company and the New York Central Railroad.

By the terms of this arrangement the Edison company will supply all the light and power for the Grand Central Terminal Building and some twenty-five other large buildings in the vicinity, all of which had formerly been supplied with electric current from the New York Central generating stations at Port Morris and Yonkers.

This agreement represents a total installation of about 30,000 kw. and a yearly consumption of more than 50,000,000 kw.-hrs. It removes the last district of any size on Manhattan that is not served by the Edison-United system.

"Besides the Grand Central Terminal itself," an article in *The Edison Weekly* states, "buildings that will be served will be the Hotel Commodore, the Hotel Biltmore, the Graybar Building, the Yale Club, the local station of the New York Post Office and the American Express-Railway Mail Service Building. Other structures included are the Postum Building, the Grand Central Palace, the apartment hotel at 270 Park Avenue, the Park Lane Apartments and the Railroad Y. M. C. A.

"By the terms of the agreement the New York Central Railroad will continue to distribute the electric current to these buildings, but instead of receiving the original power from their own power plants, as at present, it will receive all this energy from the generating stations of the Edison company. There are also facilities for the railroad to use the Edison current for traction purposes at their option."

Negotiations leading to this arrangement have been in progress for several years, becoming active last April. The contract was signed by P. E. Crowley, president of the New York Central, and delivered to the Edison company on October 5. Full inauguration of the new system will not take place for several months.

Harry Currie, assistant electrical engineer of the New York Central, who conducted the negotiations, said October 18 that while the announcement was correct in principle, he considered it premature, in view of arrangements which must be completed before the new service goes into effect.

New 75,000 Kw. Turbine for Huntley Station

A single-cylinder steam turbine is being manufactured for installation in the Charles R. Huntley station of the Buffalo General Electric Co. The new unit will be rated at 75,000 kw., and will increase by nearly 50 per cent the present station capacity of 155,000 kilowatts.

The constantly increasing demand for power in the vicinity of Niagara Falls and the fact that the present international agreement will not permit more water to be diverted from the falls for hydro-electric generating purposes, make it necessary for a continually larger amount of steam-generated power to be distributed in addition to the basic power from Niagara.

Although the Buffalo General Electric Co. a year ago installed a 60,000-kw. unit in this station to take care of increased load conditions, peak demands have occurred since, in the season of lighter loads, which indicate clearly that more capacity is needed.

The five present units are of 20,000, 35,000 and 60,000 kw. capacity. The new machine will be used to deliver base power, while the smaller ones will act as stand-bys for peak conditions. Like its five predecessors, the new unit will be of General Electric manufacture. It will be rated at 83,333 kva., 90 per cent power factor, 1,500 r.p.m., 25 cycles. The turbine will be operated under standard station steam conditions of 250 lb. pressure, 250 deg. superheat, and 1-in. absolute back pressure.

Foundation, Backed by Tanners, Sets Industrial Precedent

A fund of $1,000,000 for the permanent endowment of leather research is to be raised by the tanning industry according to a recent announcement made to the McGraw-Hill publications by Fraser M. Moffat, secretary of the Tanners Council of America.

The fund will insure the continuous and effective operation of the independent foundation incorporated last May for tanning research. This action sets a precedent for other industries that could profit by placing industrial research beyond the reach of the ups and downs of trade-association fortunes and interests.

The corporation, known officially as "The Foundation of the Research Laboratory of the Tanners Council of the United States of America at the University of Cincinnati, Inc.," has taken over the leather research work conducted for several years at the University of Cincinnati under a gentlemen's agreement. This agreement provided that no research work not of a strictly fundamental character shall be undertaken, the Council will furnish the funds needed for the prosecution of the work and the results of all research work will be freely published in reputable scientific journals.

Perley F. Walker, Kansas Engineering Dean, Dies

Perley F. Walker, Dean of the School of Engineering of Kansas University since 1913, died suddenly October 17.

Born in Embden, Me., 52 years ago, Dean Walker graduated from the University of Maine in 1896. He then obtained a master's degree at Cornell. He came to the University of Kansas in 1905 and ten years later was appointed head of the School of Engineering.

Perley F. Walker

He was recognized as an authority on water supply and had acted as consulting engineer for many municipalities, including the Wichita Natural Gas Co., Bartlesville, Okla., from 1914 to 1916, and since natural-gas expert on the cost of supply to Kansas City, Mo.

In 1923 Dean Walker was elected president of the Society for the Promotion of Engineering Education.

He wrote many papers and articles on engineering topics for various technical periodicals. He was a member of both the A.S.M.E. and the Kansas Engineering Society.

Study Diesel's Application to Airplanes

Harvard research workers are trying to find out how, and if, Diesel engines can be made light enough for airplanes. More power, economy in fuel and less fire hazard are two outstanding advantages in the adaptation of this successful type of marine engine, it is claimed.

This cutting down the weight per horsepower of Diesel engines from 250 pounds in motor-driven ships to 2 pounds for airplanes is being investigated by Dr. T. W. F. Brown of Ayr, Scotland, and David H. Alexander of Belfast, Ireland, holders of the two Blair fellowships this year, under the direction of Prof. Lionel S. Marks, of the mechanical engineering department of the Harvard Engineering School.

A.S.M.E. Plans Complete Engineering Index Service

Plans have been completed for a comprehensive system of indexing the engineering literature of the world, to be initiated the first of the year, with the new weekly engineering index service of the American Society of Mechanical Engineers.

This task will include the preparation of index items for the 1,500 technical publications of the world appearing in 17 languages in 37 countries, which are received in the Engineering Societies Library. The index items will be printed on cards and mailed weekly to the subscribers to the new service. This project was authorized by the A.S.M.E. Council at its St. Louis meeting October 8, as an important extension of the Engineering Index in its service to research and the development of industry and to bring to everyone not only in the United States but in the world the storehouse of knowledge appearing in the technical literature of the world.

The A.S.M.E. has published the Engineering Index since 1919, when it was taken over from the *Engineering Magazine*. During the eight years this book has been published by the Society, its volume of material has increased from approximately 8,000 items annually to 16,000. These were first published monthly in *Mechanical Engineering* and at the end of the year collated in an annual volume. In the limited scope of a book of this kind it is possible to give only an incomplete service, while the modern needs of industry demand complete information about published technical material throughout the world and require it promptly. Accordingly, the new plan was developed to meet this demand.

This service is made possible by the splendid co-operation of the Library Board of the United Engineering Society Library and, in addition to the augmented technical staff of the Society, the especially trained group of librarians who have on file the magazines to be indexed and who are prepared to furnish photostat copies and translations of foreign articles to those requiring them.

The new service will be under the general supervision of the Committee on Publications of the Society, of which Ralph E. Flanders is chairman, and the Finance Committee, under the chairmanship of H. V. Coes. Prof. Carlos de Zafra, of New York University, will occupy the post of director of the Engineering Index.

Boiler Production Slightly Under Last Year

The month of September recorded a slight decline in the rate of production in the boiler-manufacturing plants of the nation, bringing to an end the upward trend in productive activity which started in July and which was expected to continue through the fall months.

September activity of these manufacturing plants also was about 1.7 per cent under September of last year and 3.9 per cent under the activity recorded for September, 1925.

The month of September in past years has witnessed a material expansion in productive operations over previous months, but the current September failed to record the expansion which past history would warrent of expectation. Such is the picture of activity in the boiler-manufacturing plants of the nation as indicated by the monthly consumption of electrical energy by these plants as reported to *Power*.

The index of activity in the boiler-manufacturing industry based upon electrical energy consumption stands at 99.2 for September as compared with 103.6 for August, after adjustments are made for the number of working days in the two months. Comparative indexes of productive activity referred to the monthly average activity for the year 1925 as 100, and adjusted for number of working days, are as follows:

September, 1927	99.2
August, 1927	103.6
July, 1927	101.0
September, 1926	100.8
September, 1925	103.2
Average for first six months 1927	104.3
Average for full year 1926	105.2

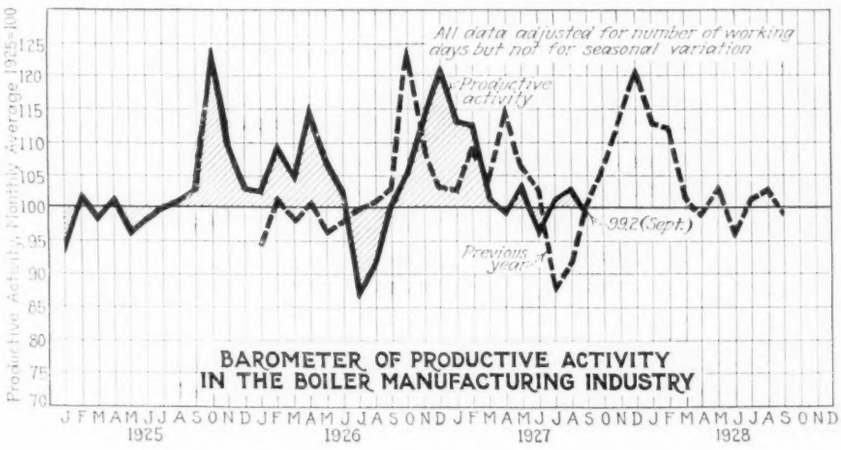
Contrary to Prevalent Conditions

The unexpected decline in activity recorded for September under August was contrary to conditions prevalent in general industry during that period. The basic figures on electrical energy consumption indicate that the productive activities of general industry during September were 7.1 per cent over August, but were 0.2 per cent under September last year.

An interesting phase of American industrial economics is pictured in the September indexes of industrial activity in that, while some of the nation's most basic industries are at present operating materially under last year, other just as basic and important industrial groups are reporting activities over those of last year. During September five of the national primary industrial groups—iron and steel, metal working, automobiles, paper and pulp and stone, clay and glass—were operating at a rate materially under the activity reported for September last year.

On the other hand, six of the important industrial groups—textiles, leather and its products, food, lumber and its products, rubber and its products, and the chemical and allied products—reported activities materially above those of 1926.

It is this equalizing or stabilizing of general American industry which is doing much to prolong the present period of prosperity in the nation as a whole.


All data adjusted for number of working days but not for seasonal variation
Productive activity
Previous year
99.2 (Sept.)
Productive Activity, Monthly Average 1925=100
125
120
115
110
105
100
95
90
85
80
75
70
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1925
1926
1927
1928
BAROMETER OF PRODUCTIVE ACTIVITY IN THE BOILER MANUFACTURING INDUSTRY

Power Prospects Bright for Saskatchewan, Canada

Recent developments appear to indicate that the electric age is dawning in the province of Saskatchewan, Canada. The question of paramount interest is as to whether the future power requirements of the province will be met by water power development in the north or by steam-electric development at coal mines in the south or by a combination of both.

As regards water power resources, R. N. Blackburn, secretary of the lately appointed Saskatchewan Power Commission has stated that Saskatchewan water power available at ordinary minimum flow is 514,451 hp., with a maximum possible development of 1,087,765 hp.

Personal Mention

Auguste G. Pratt, vice-president of the Babcock & Wilcox Co., has returned to New York after a month's trip to the West Coast.

John Van Horn, factory engineer for the Lincoln Electric Co., has been attached to the Atlanta office to assist E. A. Thornwell.

L. M. Klauber, general superintendent of the San Diego Consolidated Gas & Electric Co., has assumed his duties as president of the Pacific Coast Gas Association.

Arrighi de Cassanova, mechanical engineer of the Union d'Electricite, Paris, is sailing for France after an extended tour of American power and industrial plants, in the interest of the institute.

David L. Bacon, supervisor of automotive equipment, mechanical department, New York, New Haven & Hartford Railroad Co., is leaving for Central Europe to follow up recent developments in Diesel locomotives and light-weight oil engines.

M. Barry Watson has resigned from the position of director of engineering in the Toronto Technical Schools, which position he has held since the termination of the war, and is entering consulting practice with Harry H. Angus, also a member of this society.

William H. Patchell, past-president of the Institute of Mechanical Engineers, London, consulting mechanical and electrical engineer, sails this week for England, having completed several months of inspection and study of power problems in this country.

R. K. Runner, general manager of the Public Service Company of Chicago, Charles City, Iowa, who was president of the Charles City Gas Co. before its merger with the larger concern, has been appointed field representative also for the Chicago corporation.

Collins P. Bliss, associate dean of the College of Engineering and head of the department of Mechanical Engineering of New York University, has been appointed consulting mechanical engineer of the Bureau of Standards in Washington, D. C., Department of Commerce, according to an announcement made October 13 by Dean Charles H. Snow, of the College of Engineering.

Society Affairs

A.S.M.E. San Francisco — Engineers' Club, Oct. 27. Dinner meeting, subject: "Refinery Residium as Fuel," speaker: N. W. Thompson, engineer Shell Oil Co. of California.

The Franklin Institute, Philadelphia, Nov. 10; Prof. Wheeler P. Davey, department of chemistry, Pennsylvania State College, will speak on "Modern Research on the Structures of Metals."

A.S.M.E., Boston Section, Oct. 26, Affiliation Rooms, 615 Tremont Temple; "Possibilities in Long-Distance Steam Transmission," by C. W. Conrad, plant engineer, Bird Sons, East Walpole, Mass.

A.S.M.E. Metropolitan Section will hold its fall dinner and smoker at The Hotel Astor, New York City, at 7 p.m., November 4. Reservations may be made through I. L. Martin, A.S.M.E., 29 West 39th St., New York City.

Rochester Engineering Society—First national meeting of Management Division of the A.S.M.E. will be held in co-operation with the American Management Association and the Rochester Engineering Society at the Hotel Sagamore, Rochester, N. Y., October 26-27.

N.A.S.E., Connecticut State Association, will give a banquet and dance Saturday evening, Nov. 5, at the Hotel Taft, New Haven, Conn., in honor of National President Elmer L. Bassett. This banquet is being tendered Mr. Bassett by the combined local associations of the National Association of Stationary Engineers in Connecticut, in conjunction with the Connecticut State Supply Men's Association. Tickets will be $3 a person, and can be obtained from George F. Klopfer, 30 East Pearl St., New Haven, Conn.

A.S.M.E. Iron and Steel Division—The newly-formed Iron and Steel Division announces its first national meeting which will be held in Youngstown, Ohio, Nov. 10. C. Snelling Robinson is chairman of the Youngstown committee on arrangements.

Two outstanding technical papers will be presented in the morning, plant inspection tours will be held in the afternoon and an informal dinner will take place that evening.

The meeting will be one of joint co-operation with various sections of the A.S.M.E. and Engineers Clubs in Iron and Steel localities.

Business Notes

The Brown Instrument Co. has announced the opening of a Kansas City branch at 509 Mutual Bldg., Kansas City, Mo., with F. M. Poole as district manager.

The Reading Iron Co. announces the appointment of Jack L. Jacobson as representative in the New York territory. Mr. Jacobson will assist H. S. Carland, district sales representative.

The American Hammered Piston Ring Co., Baltimore, announces the election of T. Latimer Ford as vice-president. Mr. Ford has been connected with the American Hammered Piston Ring Co. for many years, having been with the company at the time the plant was located in Newark, N. J.

The Gardner-Denver Co., formerly the Denver Rock Drill Manufacturing Co., and the Gardner Governor Co., have added a line of portable air compressors in five sizes to their line of products. The sizes adopted will meet all requirements within the scope of a portable.

The Graybar Electric Co. has announced the opening of two new distributing houses, one in Flint, Mich., and the other in Rochester, N. Y. J. A. Royce is sales manager in Rochester and H. W. Tincher, sales manager in Flint. The Rochester house is at 182 North Waters St., and the Flint office is East Third Street.

Graton & Knight Co. has acquired the services of John C. Ruf as district sales manager on the distribution of leather belting. Mr. Ruf's present headquarters is in Greenville, S. C. For many years he represented I. B. Williams & Sons, Dover, N. H., and served for a year as president of the Johnson Belting Co., New York City.

Coming Conventions

American Boiler Manufacturers Association, winter meeting, Hotel Cleveland, Cleveland, Feb. 7; A. C. Baker, sec., 801 Rockefeller Bldg.

American Society of Heating & Ventilating Engineers, hold general meeting in New York City, during 4th week in January; A. V. Hutchinson, sec., 29 W. 39th St., New York.

American Society of Refrigerating Engineers, annual convention in New York, Dec. 5-7; W. H. Ross, sec., 37 W. 39th St., New York City.

American Water Works Association. North Carolina Section, at Durham, Nov. 7-9; H. G. Baity, sec., Univ. North Carolina, Chapel Hill; Section, at Council Bluffs, Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

American Society of Mechanical Engineers, convention during week of New York Power Show, New York City, Dec. 5-10; Calvin Rice, sec., 29 West 39th St., New York City.

Midwest Power Conference and Exhibition, at Chicago, Feb. 14-17; G. E. Pfisterer, sec., 53 West Jackson Blvd., Chicago.

National Association of Practical Refrigerating Engineers. Eighteenth annual convention and educational exhibition in Civic Convention Hall and headquarters Hotel Whitcomb, San Francisco, Calif., Nov. 29 to Dec. 2. H. Fox, 5707 W. Lake St., Chicago, Ill.

National District Heating Association, annual meeting in May; D. L. Gaskill, sec. 112 West 4th St., Greenville, Ohio.

New York Power Show (National Exposition of Power and Mechanical Engineering) will be held at the Grand Central Palace, New York City, Dec. 5-10. Address inquiries to the International Exposition Co., Grand Central Palace.

Society of Naval Architects and Marine Engineers, Thirty-fifth general meeting will be held in the Engineering Societies Building, 29 West 39th St., New York City, Nov. 10-11. Papers of interest to power engineers will be offered Nov. 11.

National Engineers' Beneficial Association, Fifty-third annual convention will be held in Washington, D. C., Feb. 14. Headquarters to be announced hereafter; Albert L. Jones, secretary treasurer, 313 Machinists' Bldg., Washington, D. C.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Oct. 12 1927
Pool 1	New York	$2.35@$2.75
Smokeless	Boston	1.48
Clearfield	Boston	1.60@ 1.85
Somerset	Boston	1.70@ 1.90
Kanawha	Columbus	1.50@ 1.75
Hocking	Columbus	1.65@ 1.90
Pittsburgh	Pittsburgh	1.75@ 1.90
Pittsburgh gas slack	Pittsburgh	1.35@ 1.50
Franklin, Ill	Chicago	2.50
Central, Ill	Chicago	2.25
Ind. 4th Vein	Chicago	2.50
West Ky	Louisville	1.40@ 1.65
S. E. Ky	Louisville	1.40@ 1.75
Big Seam	Birmingham	1.75@ 2.00
Anthracite (Gross Tons)		
Buckwheat No. 1.	New York	2.90@ 3.25
Buckwheat No. 1.	Philadelphia	3.00@ 3.75
Birdseye	New York	1.50@ 1.60

FUEL OIL

New York—Oct. 20, light oil, tank-car lots; 28@34 deg. Baumé, 5¼c. per gal.; 36@40 deg., 5½c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Oct. 5, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.60 per bbl.; 26@28 deg., $1.65 per bbl.; 28@30 deg., $1.70 per bbl.; 30@32 deg., $1.75 per bbl.; 32@36 deg., gas oil, 4.3c. per gal.; 38@40 deg., 5¼c. per gal.

Pittsburgh—Oct. 10, f.o.b. local refinery; 30@34 deg., fuel oil, 4¼c. per gal.; 36@40 deg., fuel oil, 4¾c. per gal.

Philadelphia — Oct. 13, 26@30 deg., $2@$2.06 per bbl.; 13@19 deg., $1.68@ $1.74 per bbl.; 22 plus, $1.79@$1.85; 27@30, $2.10@$2.16.

Cincinnati — Oct. 18, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5¾c. per gal.

Chicago—Oct. 15, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 87½c. per bbl.; 26@30 deg., 90c.; 30@32 deg., $1.05.

Boston—Oct. 17, tank-car lots, f.o.b. 12@14 deg. Baumé, 4¼c. per gal.; 28@ 32 deg., 5¾c. per gal.

Dallas—Oct. 15, f.o.b. local refiners, 26@30 deg., $1.45 per bbl.

THE BOILER ENGINEERING CO., 931 Federal Trust Bldg., Newark, N. J., manufacturers of the BECO boiler baffle wall, is now being represented in the Detroit territory by the E. W. Nicklin Co., General Motors Bldg., Detroit.

THE LINCOLN ELECTRIC CO., manufacturer of "Linc-Weld" motors and "Stable-Arc" welders, announces the appointment of E. A. Thornwell, of Atlanta, Ga., as representative for Georgia and eastern Tennessee.

FOOTE BROS. GEAR & MACHINE CO., Chicago, announces the purchase of the A. Plamondon Manufacturing Co., of the same city. These companies have long been engaged in the manufacture of gearing and power transmitting machinery. The A. Plamondon Co. specializes in large sizes of gears and machine-molded gears.

Trade Catalogs

BOILER BAFFLING — King Refractories Co., Inc., Buffalo, N. Y., treat of different refractory materials and operating conditions with mono boiler baffling in recent illustrated catalog.

SHAKING GRATES—McClave-Brooks Company, Scranton, Pa., treats of application of Type No. 3 grate for schools, apartment houses, hotels and public buildings, in recent illustrated catalog.

CENTRIFUGAL AIR COMPRESSORS—General Electric Co., Schenectady, N. Y., treat of applications, operating characteristics and ratings of single-stage centrifugal air compressors in recent illustrated pamphlet GEA-233 A.

TRAMRAIL SYSTEMS—The Cleveland Crane & Engineering Co., Wickliffe, Ohio, treat of the handling of material in different industries by means of overhead tramrail systems in recent illustrated pamphlet No. TR-558.

RECORDING AMMETERS—The Bristol Co., Waterbury, Conn., treat of recording electrical instruments, volt meters, ammeters, watt meters, millivolt meters, frequency meters, and shunt ammeters in a recent illustrated Catalog 1502, Ammeter section.

FEED-WATER HEATERS—The Ellicott Co., Pittsburgh, has carefully prepared Bulletin D-2 entitled Feed-water Heaters which is just off the press. This is a 34-page bulletin, printed in two colors and profusely illustrated. It covers open heaters, deaerating heaters and closed heaters with a very complete discussion of construction features, and details of design. Copies of the bulletin may be had upon request to the Ellicott Co. general offices at Jeannette, Pa., or to any Ellicott Co.'s district offices.

AUTOMATIC GUIDE-RAIL LUBRICATORS—The Atlas Elevator Devices Co., 124 West 31st St., New York City, has issued a new four-page bulletin describing its automatic guide-rail lubricators for freight and passenger elevators. The lubricators are of the stationary type and can be mounted either on the top end of the guide rails or in the pent house with the elevator machinery.

UNIT HEATING — The American Blower Co., Detroit, describes in an illustrated bulletin the Venturafin method of unit heating as applied by the Austin Co. in the new Oakland-Pontiac plant of the Oakland Motor Car Co. This installation, the subject of the bulletin, consists of 169 units, each provided with a recirculation box. The system has a heating capacity of 111,000,000 B.t.u. per hour and circulates 1,650,000 cu.ft. of air per minute throughout the buildings. The method requires a total of 200 motor horsepower.

NEW PLANT CONSTRUCTION

Calif., Chico—Chico Ice & Cold Storage Co., 13th St. and Park Ave., had plans prepared for the construction of an ice plant on Park Ave. Estimated cost $60,000. Private plans.

Calif., Los Angeles—Congregation B'nai B'rith, will soon receive bids for the construction of a synagogue including steam heating system, etc., at Wilshire and Hobart Blvds. Estimated cost $1,000,000. Allison & Allison, Hibernian Bldg. and A. M. Eldelman, 824 H. W. Hellman Bldg., are associate architects.

Calif., Los Banos — Union Ice Co., 354 Pine St., San Francisco, plans the construction of first unit of ice plant 20 ton daily capacity on Eye St. here. Estimated cost $56,000.

Calif., San Francisco—E. V. Lacey & J. Steur, Hearst Bldg., plans the construction of a 17 story apartment building at O'Farrell and Leavenworth Sts. Estimated cost to exceed $500,000.

Calif., San Francisco—Methodist Book Concern, 5 City Hall Ave., awarded contract for the construction of a 23 story church and hotel at McAllister and Leavenworth Sts. to Cahill Bros., 55 New Montgomery St. Estimated cost $2,000,000.

Calif., San Francisco—F. C. Morgan, et al, Hunter-Dulin Bldg., plans the construction of a 33 to 40 story office building, etc. at Sutter and Stockton Sts. Estimated cost $4,750,000. Miller & Pflueger, 580 Market St., are architects.

Calif., San Francisco—Willie Ritchie, et al, c/o S. Heiman, 57 Post St., is having plans prepared for the construction of an ice skating rink, etc. Estimated cost $250,000.

Conn., Stamford—Stamford Gas & Electric Co., 11-17 Bank St., awarded contract for addition to South Street power house, to T. J. Pardy Construction Co., 1481 Seaview Ave., Bridgeport. Estimated cost $95,000.

Ga., Atlanta—City voted $258,000 bonds for waterworks improvements including pump house, pumping equipment, mains, etc. at Hempill plant. W. Z. Smith, City Hall, is engineer.

Ill., Chicago—Delaware Building Corp., c/o Klaber & Grundfeld, 431 North Michigan Ave., Archts., awarded contract for masonry, etc. for a 21 story hotel at 101-109 East Delaware Pl. Estimated cost $1,500,000. Lowenberg & Lowenberg, 111 West Monroe St., are associate architects.

Ill., Chicago—C. E. Howland, 104 Bellevue Pl., is having preliminary sketches made for the construction of a 16 story apartment building at 102-110 Bellevue Pl. Estimated cost $1,300,000. Huszagh & Hill, 6 North Michigan Ave., are architects.

Ill., Chicago—R. R. Myers, 5509 Hyde Park Blvd., awarded contract for a 16 story apartment building to Heggeman-Harris Corp., 431 North Michigan Ave. Estimated cost $550,000.

Ill., Chicago—Syndicate, c/o R. F. France & Co., 155 North Clark St., Archt., are receiving bids for a 13 story apartment building at 5820 Kenmore Ave. Estimated cost $600,000.

Ill., Chicago—Syndicate, c/o Quinn & Christensen, 360 North Michigan Ave., will soon receive bids for the construction of a 17 story apartment at 5520 Sheridan Rd. Estimated cost $1,000,000.

Ill., Chicago—Tebbetts & Garland, 16 North Michigan Ave., is having plans prepared for the construction of a 12 story office and stores building at 16-30 West Washington St. Estimated cost $1,900,000. Schmidt, Garden & Erickson, 104 South Michigan Ave., are architects.

Ill., Chicago—Wolf, Harper, Sexton, & Treaux, 431 North Michigan Ave., Archts., are receiving bids for the construction of a 7 story apartment building including central refrigeration plant, boilers, pumps, elevators, etc., at 6530 Kenwood Ave., for Beaconsfield Building Corp., c/o architect. Estimated cost $500,000.

Ill., Waukegan—Missionary Sisters of Holy Ghost, Techny, Ill., will soon award contract for the construction of a 6 story hospital including two electric elevators, etc. at Washington St. and Keller Ave. here. Estimated cost $1,000,000. Herman J. Gaul, 228 East Superior St., Chicago, is architect.

Ind., Hammond—State Line Generating Co., awarded contract for the construction of a boiler room, turbine room and switch house 420 ft. x 339 ft. 110 ft. elevation, to Herlihly Bros., 6 North Michigan Ave., Chicago, Ill. Estimated cost $2,000,000.

Ia., Marshalltown — Continental Leland Co., 25 West 43rd St., New York, plans the construction of a 6 story hotel here. Estimated cost $600,000.

Ia., Waterloo—Tanguey & McGinn, c/o Hotel Russell-Lamson, is having plans prepared for the construction of a 9 story hotel including elevators, etc. Estimated cost $600,000. H. L. Stevens Co., 30 North Michigan Blvd., Chicago, Ill., is architect.

La., West Monroe—The Ouachita Ice & Fuel Co., is having plans prepared for the construction of an ice and cold storage plant. Estimated cost $45,000. G. E. Wells, Security Bldg., St. Louis, Mo., is consulting engineer. This corrects report of Sept. 6 issue noted under West Monroe, Pa.

Mass., Arlington (Boston P.O.)—Edison Electric Illuminating Co., 39 Boylston St., Boston, is receiving bids for the construction of a sub-station on Mystic St. Estimated cost $40,000. Bigelow & Wadsworth, 120 Tremont St., Boston, are architects.

Mass., Somerville (Boston P. O.)—City, L. M. Conwell, Mayor, City Hall, taking bids for addition to high school including central heating plant on Highland Ave. Estimated cost $1,250,000. F. I. Cooper Corp., 172 Tremont St., Boston, is architect.

Mich., Detroit—Griswold Amusement Co., 1313 Dime Bank Bldg., is having plans prepared for a 15 story office building including steam heating system, etc. on Griswold St. A. Kahn, 1900 Marquette Bldg., is architect.

Mich., Detroit—Owner, c/o R. Finn, 415 Brainard St., Archt., is having plans prepared for the construction of a 12 story apartment including steam heating and ventilation systems, boilers, elevators, etc. Estimated cost $1,500,000.

Mich., Pontiac—Oakland Motor Co., is having plans prepared for the construction of an auto factory including central power plant on Oakland Ave. Estimated cost $2,000,000. A. Kahn, 1000 Marquette Bldg., Detroit, is architect.

Minn., Minneapolis—Calhoun Beach Holding Co., E. R. Buell, Secy., Lincoln National Bank Bldg., awarded contract for an 8 story club house on Dean Blvd. and West Lake St. to Fleischer Engineer & Construction Co., 407 Loeb Arcade. Estimated cost

$1,320,000. Steam heating system, elevators, etc. will be installed.

Minn., Minneapolis — Anderson-Nelson Construction Co., 2801 Park Ave., will build an 8 story apartment including steam heating system, etc. at 22nd St. and Pleasant Ave. Estimated cost $2,100,000. Newstrom-Lindquist Co., 810 Lumber Exchange Bldg., is architect.

Miss., Howell—Mississippi State Hospital Removal Improvement & Land Sale Comn., P. L. Brown, Secy., Jackson, will soon award contract for addition to hospital including power plant, etc. here. Estimated cost $500,000. N. W. Overstreet, Mississippi Fire Bldg., Jackson, is architect.

Miss., Water Valley—City awarded contract for water and light plant improvements including reservoir, power plant equipment, etc. to George S. Volt, Ripley, Tenn. Estimated cost $43,964.

Mo., Campbell—City, C. A. Bradshaw, Clk., will soon award contract for improvements to electric light plant including power plant machinery and auxiliary equipment, etc. Estimated cost $50,000. A. C. Moore, Joplin, National Bank Bldg., Joplin, is engineer.

N. J., Bradley Beach—Hotel La Reine Corp., M. Sparks, Dir., Ocean Ave., is having plans prepared for the construction of a 6 story hotel including steam heating system, etc. at La Reine Ave. Estimated cost $500,000. L. Brooks, 65 Madison Ave., New York, Archt.

N. J., Jersey City—American Can Co., 120 Broadway, New York, will build a 7 or 8 story factory including steam heating system, elevator, etc. at St. Pauls Ave. and Erie R.R. here. Estimated cost $2,000,000.

N. J., Newark—Presbyterian Hospital, 25 South 9th St., will soon award contract for a 6 story hospital including steam heating and ventilation systems, boilers, elevators, etc. at 9th Ave. and 9th St. Estimated cost $500,000. Sutton, Sutton & Calkins, 102 Broad St., are architects.

N. J., Newark—Robert Treat Hotel Co., 154 Park Pl., is having plans prepared for a 16 story addition to hotel including steam heating system, etc. at 44 Park Pl. Estimated cost $500,000. Guilbert & Betelle, 20 Branford Pl., are architects.

N. J., Paterson—East Side Realty Co., W. F. Glasser & Co., 126 Market St., will build a 5 story apartment including steam heating and refrigeration systems, boilers, etc. in Thirty-Third St. Estimated cost $500 000. A. Haenicken, 126 Market St., is architect. Work will be done by separate contracts.

N. J., Somerville—Crystal Ice & Coal Co., 307 Arlington Ave., Plainfield, awarded contract for the construction of an ice plant including engine room, etc. to Alexander Milne, 15 Watchung Ave. Estimated cost $40,000.

N. Y., New York—Dept. of Public Welfare, Municipal Bldg., will receive bids until Oct. 28 for addition to power house, etc. at Lincoln Hospital, Concord Ave. and East 141st St.

N. Y., New York—Faybert Realty Co., c/o P. J. Heaney, 1363 Westchester Ave., is receiving bids for the construction of an ice skating rink and refrigeration plant at Westchester and Whitlock Aves. Estimated cost $200,000. D. M. Ach Archt., 1 Madison Ave., is architect. A. Nickerson, 136 Liberty St., is engineer.

O., Akron—City will receive bids about Oct. 28 for an 8 story hospital, nurses' home, power house, etc. Estimated cost $600,000. Good & Wagner, Mohawk Bldg., are architects. A. G. Simon, Hippodrome Bldg., is engineer.

O., Cincinnati—R. A. Casey Realty Co., Garfield Hotel, plans a 16 story addition to hotel on Race St. Estimated cost $2,000,000. G. W. Drach, 171 Union Trust Bldg., is architect.

O., Cleveland—Berkner Realty Co., c/o G. J. Paul, of Paul Bros., Fidelity Bldg., is having plans prepared for a 12 story apartment building including steam heating, refrigeration and ventilation systems, elevators, etc. at Euclid Ave. and East 40th St. Estimated cost $1,500,000. G. Ebeling, 737 Prospect Ave., is architect.

Okla., Tipton—City plans an election to vote $15,000 bonds for waterworks improvements including deep well, reservoir, air compressor, etc. Long & Co., Colcord Bldg., Oklahoma City, are engineers.

Pa., Philadelphia — Maxwell Building Corp., C. J. Maxwell, 1528 Walnut St., plans a 21 story office building at 16th and Walnut Sts. Estimated cost $1,500,000. S. M. Green & A. H. Lacella, Springfield, Mass., are architects.

Pa., Philedalphia — Pennsylvania R.R., Broad St., Station, plans the construction of a cold storage plant at Oregon and Delaware Aves. T. J. Skillman, is chief engineer.

Texas—Central Power & Light Co., F. C. Ludden, Mgr., San Benito, plans the construction of cold storage plants at Lasara and La Feria. Estimated cost $35,000 and $40,000 respectively.

Tex., Glen Rose—City voted $40,000 bonds for waterworks improvements including pumping unit, etc. H. B. McAllister, 519 North 12th St., Waco, is engineer.

Va., Richmond—Monroe Terrace Realty Co., is having plans prepared for a 12 story apartment building. Estimated cost $800,000. A. C. Bossom, 680 Fifth Ave., New York, N. Y., is architect. Weinberger & Weishoff, 247 Park Ave., New York, N. Y.

B. C., West Vancouver—British Columbia Electric Ry. Co., Ltd., 425 Cowall St., plans the construction of a sub-station, 10,000 kw. capacity. J. I. Newell, 425 Cowall St., is engineer.

Ont., Toronto—Canadian Pacific Ry. Co., Montreal, Que., awarded contract for a 28 story hotel on Front St. here. to Anglin Norcross Ltd., Temple Bldg. Estimated cost $10,000,000. Steam heating system, elevators, etc. will be installed.

Ont., Toronto—Dominion Boxboards Ltd., 130 Duchess St., awarded contract for the construction of a boxboard plant including power plant, etc. to Toms Contracting Co., 245 St. Clair Ave. E. Estimated cost $1,000,000.

Equipment Wanted

Boiler House Equipment—Arrow Electric Co., Hawthorne St., Hartford, Conn., is receiving bids for boiler house equipment including two high pressure boiler feed pumps, etc.

Coal Unloading Towers—Boston & Maine R.R., A. W. Munster, Purch. Agt., Boston, Mass., will receive bids until Oct. 28 for two coal unloading towers complete with machinery.

Compressors, Motors, etc. — Linde Air Products Co., subsidiary of Union Carbon & Carbide Co., 30 East 42nd St., New York, N. Y., plans to purchase compressors, motors, etc., for proposed plants, at Allentown, Pa., Casper, Wyo., and Erie, Pa. Estimated cost $150,000 each.

Engine and Generator—City of Stillwell, Okla., plans to purchase a 250 hp. Diesel engine and generator for proposed electric light plant. Estimated cost $30,000.

Engines—City of Cushing, Okla., plans to purchase 800 hp. Diesel engines, etc., for proposed electric light plant. Estimated cost $75,000.

Engines and Generators — Constructing Quartermaster, Washington, D. C., will receive bids until Nov. 2 for 20 kw. Diesel engines and generators for electric power and light system at Governors Island, N. Y.

Hoisting Equipment—A. Lagrasse, 2147 Pleasant St., Fall River, Mass., plans to purchase hoisting machinery and equipment for ice house at North Dartmouth, Mass., to replace fire loss. Estimated cost $50,000.

Ice Plant Equipment—Bids and quotations are desired on suitable machinery and equipment for ice plant, 5 ton daily capacity to be erected at Agua Priesta, Sonora, Mexico. Details are available under reference Mexico No. 257644, Dept. of Commerce, Washington, D. C.

Motors, etc.—Mogadore Insulator Co., F. W. Butler, Pres., Mogadore, O., plans to purchase four motors, etc., for proposed porcelain plant. Estimated cost $100,000.

Pump — City of Blair, Okla., plans to purchase a motor driven triplex pump, etc., for proposed waterworks system. Estimated cost $25,000.

Pump, etc.—City of Ironton, Mo., will receive bids on or after Oct. 28 for a plunger type pump, etc., for proposed waterworks improvements.

Pumping Unit—C. T. Bogart, Purch. Agt., Spokane, Wash., will receive bids until Oct. 27 for a 4,000,000 g.p.d. pumping unit.

Pumps and Motors—Township of York, Ont., will receive bids until Oct. 31 for furnishing and installing one 900 g.p.m. and one 1,500 g.p.m. sewage pumps complete with electric motors, etc., in Black Creek pumping station.

Storage Batteries—P. O. Box 254 Station A, Boston, Mass., plans to purchase storage batteries for proposed light plant.

Switches, Insulators, Transformers, Etc.—Dept. of Public Works, Supplies & Tenders Board, Wellington, N. Z., will receive bids until Jan. 17, 1928 for three sets air break switches with operating gear, two sets earthen switches; one set choke coils; one steel structure complete with strain and post insulators; connectors tees and foundation bolts; spares; two post type insulators for air break switch; one 2,250 kva. main panel iron clad with instruments complete; one service transformer panel iron clad with three ph. switch fuses and 15 kva. transformer complete; one meter panel with kva. and kw.hr. metering equipment complete; also until Jan. 24 for one 1,500 kva. main panel iron clad with instruments complete; one service transformer panel iron clad with three ph. switch fuse and 15 kva. transformer complete, and one metre panel with kva. and kw.hr. metering equipment complete.

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